Total Integrated Clinic Information System (TICIS)

By

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Dissertation submitted in partial fulfillment of the requirements for the Bachelor of Technology (Hons) (Information System)

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CERTIFICATION OF APPROVAL

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Information System Programme
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Approved by,

(Mr. Helmi Rais)

UNIVERSITI TEKNOLOGI PETRONAS
TRONOH, PERAK
DEC 2004

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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 here have not been undertaken or done by unspecified sources or persons.

AHMAD FAISAL ASRA BIN HASSAIM

ABSTRACT

Information technology is proving to be a vital element in the administration of healthcare. Specifically, most healthcare institutions in this country are adopting information systems that provide more accurate and timely information regarding patient care. Appropriate patient care requires the use of clinical procedures as well as applied research protocols. Information must be accurate and immediately available to individuals involved in the care of patients. *"Total Integrated Clinic Information System"* was introduced as a way to facilitate a centralized patient information repository. Benefits realized by this system included improvements in patient care, clinical research, and patient service and satisfaction. The ultimate goal of this project was to provide a paperless patient medical record that linked research and clinical data
(Keywords: project, Administration of Healthcare, centralize patient information system, clinical research, paperless patient medical record, research, clinical data, individuals, patient care.)

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ABBREVIATION AND NOMENCLATURES

1. IT	Information Technology
2. ICT	Information Communication and Technology
3. IOM	The Institute of Medicine
4. RACGP	The Royal Australian College of General Practitioners
5. ECG	Electrocardiogram
6. EMR	Electronic Medical Record
7. EPR	Electronic Prescription Record
8. EEPR	Electronic Patient Registration Record
9. WWW	World Wide Web
10. CGI	Common Gateway Interface
11. HTTP	Hypertext Transfer protocol
12. NHS	National Health System
13. QA	Quality Assurance
14. RDBMS	Relational Database Management System
15. TICIS	Total Integrated Clinic Information System
16. SSL	Secure Socket Layer
17. FDA	Federal Drug Association

CHAPTER 1
INTRODUCTION

Increasing number of patients in regards of the increasing population of Malaysian, leads to the needs for medical practitioners to attend as many patients as possible at one time without any medical trade-off to be held. Faster and accurate medical treatment plays a major role in modern medicine today. The use of IT technology into medical practices had been identified by the government as a vital catalyst in improving Malaysian's health quality in this era of Information Communication and Technology (ICT). Government's Information System Strategic Plan was developed in 1994 to improve efficiency in medical services using Information Technology (IT).

Although technological advancements in science have greatly improved medical care in recent decades, improvements in the management of patient information have been languid. Many healthcare institutions continue to rely on paper-based medical records as the primary source of patient medical and demographic information.

While most health care institutions employ information systems to manage some aspects of patient care, the systems are often disjointed. In such cases, communication between departments is reduced to printing the information from one system and sending that output to the other department. Ultimately, these paper records are transferred to the patient medical record. Delayed or inappropriate patient treatment is often due to miscommunication, lost or destroyed records, and the overall inefficiency of the paper system.

1.1 Background of Study

Keeping an eye on health care trends has never been more important. We are accustomed to constant change but nothing compares to the changes predicted for the next few years. Already, there are new requirements for information technology (IT) and the sharing and

management of data. In addition, clinical information systems have matured and the awareness of Internet will pave the way for new health care delivery models.
Most of all, the transformation taking place in health care is creating the need to improve the quality of information systems. Exactly what kind of transformation is taking place?

- Creating a Total Integrated Clinic Information System that enables easy access to patient data and records, reduces paperwork and improves medical staff productivity.
- Shorter waiting time for services as the most pleasant transformation. In the collection of prescribed drugs, for example, a patient can get his medicine as soon as he reaches the drug counter as the list of drugs would have been relayed electronically from the clinic to the pharmacy section.
- Developers continue to consolidate at rapid speeds creating the need to tie information systems together at their disparate locations (creating integrated patient's information networks)
- Medical Institutions are driving the need for information systems to share patient's data with one another.
- The Internet enables patients to be involved with their health care and facilitate communications between patients and doctors. The Internet reinvents the patient-doctor relationship and empowers patients to make choices about their health care.

This is where information technology and medical institutions become relevant and useful as they can assist in medical staff daily job.

1.2 Problem Statement

Quick and timely clinic operation plays a major aspect in modern healthcare today. Nowadays it is vital to ensure that the patient's medical information processed with high speed and precision. Yet most clinics still prefer to use manual methods of recording and storing information. Preliminary research done on hospital information tracking system has identified several problems in manual methods of tracking the patients.

- ***Time constrain:*** manual information tracking requires much time which is unacceptable in today's medicines treatment process. Modern medicine standards require the doctors to pay attention to its patients rather than doing paperwork.
- ***Patient volume control:*** Large patient volume will create a lot of paperwork requiring more time to process and greater attention to store and keep track of it.
- ***Data Security:*** Medical data recorded manually might get destroyed or stolen which is unacceptable considering the level of data sensitivity
- ***Drug inventory administration:*** Due to large drug inventory problems like inventory control and updating arising, complicating and sometimes delaying the treatment process. Thus the drug administration has to be computerized.

The Institute of Medicine's (IOM) report estimated that 45,000 to 98,000 patients die each year from preventable medical errors (Healthcare Industry Research & Advisory Services, "2000 Top 10 List." Gartner Group). In response to the report, health care providers realize that the only way to reduce the level of errors is through better access to information. Installing clinical information systems provides the ability to capture prescription information electronically and alert physicians to existing drug allergies or any drug-drug interactions. Automated order entry also addresses some of the drawbacks of paper documentation such as illegible and misinterpreted handwriting.

Problems listed above make the patient and drug inventory manual tracking methods cumbersome and ineffective. New computerized tracking system has to be developed in order to increase the productivity of medicine institutions.

1.3 Objectives and Scope of Study

The objectives of this project are:

1. To develop a prototype web-based system that could assist the medical staff to perform their daily work faster and with great efficiency.
2. To develop an integrated patient's information database.
3. To assist the medical staff in controlling the large volume of medical information
4. To achieve greater control of drug inventory and improve the drug administration

The scope of this project is mainly on:

1. The target user are clinic's assistance and doctors
2. The type of patient that been chosen are walk in-patient.
3. The type of treatment that been chosen are common treatment that often happen everyday.
4. Patients ID card would be used to capture the patient information before it would be transmitted to the waiting list.

CHAPTER 2
LITERATURE REVIEW

2.1 Medical Records

It is theoretically possible for a doctor to give high quality care without any record whatsoever given superhuman memory, constant availability and total recall. Such a genius will have no staff, very few patients and will leave no trace of his excellence for others to follow or understand. For the rest of us, records are the essential tool for care, professional development, observation, understanding, assessment and protection.

The basic problem for general practitioners is to create and maintain a record sufficiently flexible and comprehensive to cover all facets of family practice and sufficiently structured to highlight essential information and document the evolution and solution of patients' problems.

Following the design in 1972 and extensive trial of a prototype, in 1974 the RACGP introduced a record system which, after further trials, has been widely used. It was designed to satisfy the needs and expectations of doctors, patients and staff. It embodies the principles of simplicity of record and retrieval, comprehensiveness, flexibility, legibility, economy and effectiveness.

Some features of the current Health Record System include:

- **Information sheet**

This lists basic details of name, address, date of birth etc for the purposed of registration of new patients. The doctor immediately obtains information on family structure when the first person, perhaps a child, attends. A card which can double as an index is also an option.

- **Health summary sheet**

Here are listed problems past and current. It provides a readily accessible summary of the patient's medical history, invaluable for the consultation, referral letters and rapid review.

The most demanding exercise in record keeping is its initial commencement and updating. Reference to the Users Guide will help to facilitate this process. Other forms for data acquisition and follow-up include Health Data Base and Preventive Activities forms for all ages, Percentile Charts for children, and Obstetric Care forms.

- **Progress notes**

This part is the day-to-day working record of clinical care. They are designed to employ a problem oriented approach. In this method, data is recorded as:

1. Subjective - history given and elicited.
2. Objective - clinical and, where applicable, laboratory findings.
3. Assessment - initial diagnosis impressions.
4. Plan - the programmed of investigation, management or referral proposed.

- **Medication list**

One of the most difficult problems of recording is to update medication lists of drugs actually being taken. People attend elsewhere, and sometimes discontinue treatment for various reasons. It is wise to keep track on medication, frequency of prescriptions and to maintain vigilance with suspected abuse. Medication records form part of the system.

- **Flow charts**

This is the part of the system for recording selected parameters in the management of long term problems, e.g. hypertension and diabetes.

- **Report summary**

For mounting x-ray and pathology reports, ECGs and to index retained consultants letters. Reports and letters may be scanned or précised and typed cost effectively.

2.2 Medical Errors and the Record-Keeping System

There has been substantial discussion about the Institute of Medicine (IOM) report on medical errors. The implications are that many thousands of patients are killed or injured by mistakes each year and that we have not developed methods for reducing the error rate.

Some of the medical errors include errors in procedures, mistakes in blood transfusion, mistakes in diagnosis because of faulty laboratory results or radiological interpretations, and mistakes in the administration of medications. There have been cases of patients being prescribed the wrong medication because of doctors' poor handwriting. For example, codeine, which is used for moderate pain or serious cough, may be easily mistaken for cardene, which is used for treating high blood pressure and chest pain. Such mistakes could have undesirable or even fatal consequences.

The Institute of Medicine USA in a recent article entitled "To err is Human: Building a Safer Health System", pointed out that medical errors caused an estimated 44,000 to 98,000 deaths annually in hospitals in the United States. Research carried out over the past few years in the United States, United Kingdom and other European countries indicated that thousands of injuries harm and deaths due to facility failures and medical errors could have been prevented.

In a sample of 30,195 randomly selected hospital records, reported in The New England Journal of Medicine way back in 1991, 1,133 patients (3.7%) with disabling injuries caused by medical treatment were identified. Drug complications were the most common type of adverse event (19%), followed by wound infections (14%) and technical complications (13%). Nearly half the adverse events (48%) were associated with an operation. The proportion of adverse events due to negligence was highest for diagnostic mishaps (75%), noninvasive therapeutic mishaps ("errors of omission," 77%), and events occurring in the emergency room (70%). Errors in management were identified for 58 percent of the adverse events, among which nearly half were attributed to negligence.

The IOM report identifies numerous causes of medical errors, some of which may be difficult to correct. For example, hospital-acquired infections require changes in surgical and postoperative care procedures, but many of the problems and the errors (including drug complications) result from communication failures, inadequate data reporting, insufficient follow-up with ongoing patient care, or poor documentation. Adverse events due to negligence are estimated to constitute 27.6 percent of adverse events, and it is often these stories that reach the media, and are aired in political forums.

As clinicians, their main role is the health manager for patients who consult them. This role requires them to know their patients' current and past medical history, physical findings, laboratory results, and outcomes of various therapies – whether they are medication or procedure. This knowledge may require attending the individual patient during a procedure, examining images personally, or reviewing a laboratory report. Regardless of the action, the totality of these demands often exceeds the capacity of one physician to gather, review, and act on the information on every patient currently under care. As we progress in medicine, the amount of data on our patients is likely to increase, and the information load is likely to become more unmanageable. Yet, as a profession, they have not created the information systems that would allow them to manage the data efficiently and avoid the medical mistakes that arise from lack of information or lack of communication. Applying information systems to drug order entry, for example, is estimated to reduce the error of drug prescriptions by more than 60 percent.
This would make a substantial gain in reducing medical errors by improving communications, data reporting, and documentation – all amenable to an organized approach using modern medical informatics, computers, and database technology. The healthcare services in this country, like in any other country, are vulnerable to risks and associated errors. The Ministry of Health is aware of the possible occurrences of such mishaps and errors, and is taking steps to ensure that such risks are kept to a minimum.

2.2.1 Filing systems

Many practices use record cards alphabetically filed in drawers. Access is limited, misfiling common, expansion difficult as it involves periodically relocating cards, and culling (withdrawal of obsolete records) tedious.

In the current Health Record, folders are filed on open shelves. The usual method is to provide seven shelves of which the least accessible (the top and bottom) are used for culled files and storage. Each of the shelves accommodates approximately 400 files. In planning the total shelf space required the figure of 2000 files per doctor is usually suggested, but this may be modified in the light of prevailing and anticipated doctor/patient ratios and the nature of the practice. Shelves may be free standing, or against a wall in a compact and readily accessible position.

Letters or numbers? It is much easier to remember numerical rather than alphabetical sequences hence the chances of misfiling are less with the former. Record numbers are allocated from a master list in which is also recorded the patient's name and the date of allocation. Numbers may be given either to each individual or to the family, with an identifying suffice for that member, i.e. 1 and 2 for parents, 3 for the eldest child and then in birth order. It will so be necessary to maintain an alpheronumeral index to the system which records address and any other useful information. The Index may take the form of a card index, which can double as a record of other information for statistical and research purposes or an instant index in which the items are entered on narrow moveable strips displayed on open panels in a stand that provides rapid reference for the reception staff. The index is an ideal computer application.

2.2.2 Terminal digit filing

For uniform distribution of files, orderly growth and ease and speed of location, terminal digit filing is recommended. In essence a file is placed on the shelf corresponding to the last digit of its number.
As a safeguard against misfiling color coding may be employed. A color strip on the outer edge of the folder denotes the shelf number by its particular color and the approximate position on the shelf by the level at which it appears.

2.3 Linking Disparate Healthcare Information Systems

Healthcare organizations have spent billions in recent years on information technology, but we still are not having a sufficient impact on patients and the quality of care they receive. For example, we have seen tremendous improvements in the capabilities of clinical information systems used within health plans. Artificial intelligence tools, such as logic engines and neural networks, enable disease management programs to look at co morbidities, services and medications and to differentiate between high, moderate and low-risk patients.

The technology is impressive, but it is still far from reaching its full potential because of limitations in how the implications of such analyses are communicated to the patients, their families and their physicians. To allow technology to "go the last mile," healthcare IT systems need to reach the point of care, intelligently integrate the myriad of available information sources and be easier to use.

2.3.1 Internet Based Repository of Medical Records

A patient's medical record has always been a dispersed entity. Literally defined, it is the accumulation of medical information concerning the patient. Ideally, this information is bundled in a single folder with the patient's identification data on the cover. In real life, this information is scattered between several archives (computerized and paper based) in various locations, often under different identifier numbers. Much of the information in the records is obsolete, redundant, duplicated, or indecipherable to the extent that it does not benefit the patient at the point of care

Some solutions are emerging rapidly from innovative companies that see the need for integrated medical information systems. Consider a modern health system (in the past, we would have called it a hospital) that consists of several hospitals and associated physician practices. Today, it is rare to find a patient information system that is available to all of the necessary parties in the health system. To make these data available, each of the information centers (clinical laboratory, diagnostic imaging, catheterization, echocardiography, stress testing, nuclear imaging, pharmacy, and many other services) must be linked in a single network and made available to practitioners in the health system's hospitals, clinics, and private offices of physicians. All aspects of the relevant medical information, including the physician's medical record, must reside in the information system, and it must be available at all times to all authorized users of the system, which should include the patient.

Although most physicians do not expect this type of integrated medical information system to become available for at least 10 years, the rate of advance in a number of commercial programs and the glaring need to reduce medical errors are likely to make these systems available sooner. Consider the growth of several medical information systems: What started as an information Web site for patients and physicians has evolved in the case of Healtheon/WebMD (www.webmd.com), Medscape (www.medscape.com), and Dr Koop (www.drkoop.com) into the beginning of an integrated medical information system that encompasses insurance information, laboratory information, medical education, and consumer medical information – all available through a single Web portal that is secure and password protected.

Information systems like these will integrate the information databases of an entire health system and make all of the information available through a Web portal. By using the Web as the network, information will be available at any location where access to the World Wide Web is possible. Two pieces of this plan are currently missing for physicians: portability and efficient data entry of medical notes. Industry is aware of these needs. Currently under development are hand-held devices that provide wireless access to the World Wide Web. When voice recognition is added to these devices, we will be able to enter clinical notes directly into computerized patient records. When this system is completed, there will be no need to dictate letters to other physicians because each provider will have access to the complete medical record. All physicians involved in patient care will be able to view laboratory results, images, and clinical notes obtained from many sources. Data will be available at distant sites so that a patient traveling far from home could visit a physician in that area who has up-to-date records. Medication lists will be verifiable from the pharmacy to be sure the patient receives what was prescribed. And, when the systems are in place, checks can be placed on medications, drug interactions, and abnormal test results to trigger an urgent message. The advantage of using the World Wide Web will be its ubiquity. Access will be global – for both physician and patient.

When time allows, the work day may contain a period for review of charts on office patients currently under treatment. With an informatic system, this could be done through a single portal anywhere Web access is available, and instructions on the next treatment step could be transmitted directly to the patient by telephone or e-mail. The full integration of this enormous database, made available to the physician-health manager through a single portal, is likely to be the only way that we can ultimately improve the safety of our health care system.

2.3.2 World Wide Web as a Powerful Tool

The World Wide Web is becoming a popular medium for providing access to clinical information systems. One advantage of the Web environment is the ability to link disparate components, servers, Applications and even clinical information systems themselves, into more complex systems. There are many challenges presented by the Web, including the provision of privacy and confidentiality. The Web-based nature of a system has proved ideal for allowing a variety of faculty, systems programmer/analysts, students and fellows to develop components which can be incorporated easily into medical application.

Web services provide a standardized approach for publishing and accessing services and information via internal and external networks. They provide technical standards that enable disparate computer technologies to connect seamlessly with legacy systems and different business functions. They also enable internal networks to communicate on a secure basis with outside organizations and individuals.

For example, MEDecision's iEXCHANGE™ system uses Web services technology to integrate functions provided by interactive voice technology, electronic data interchange and Web-based applications available over the Internet. This allows health plans to collect and share with physicians the information obtained from members, hospitals and other physicians over the telephone and the Internet from a centrally located information base. The system supports the processing of referrals and authorizations as its core financial justification, but it can also link medical management software with various databases, enabling the clinical and financial assessment of care management alternatives.

In addition to making information more accessible, we need to make it easier to use. On average, a physician spends less than 12 minutes with a patient in his office. A physician cannot spend 10 of those minutes scrolling through pages of journal articles. The correct information must be presented in a single view. Software must have intuitive, interactive capabilities, allowing a physician or nurse to make queries and receive immediate responses.

In the coming years, we will see the increasing use of electronic medical records and transmission of data by home monitoring and implantable or wearable medical devices. The new data sources, when coupled with new types of analytical software, have the potential to reshape the way we deliver healthcare in Malaysia.

2.4 "Total Integrated Clinic Information System" replacing the old

"Total Integrated Clinic Information System" is a web-base system that would be used by medical staff in assisting the doctor in their daily job. The system provides one stop solution for clinic and hospital in managing patient's records. It consists of 3 main components that are Electronic Medical Record (EMR), Electronic Patient Registration Record (EPRR) and Electronic Prescription Record (EPR). With this system, we can achieve paper-less environment and efficient inventory and management control.

The integration of clinical computer systems both within and across institutions is a very difficult problem. The heterogeneous nature of data storage structures and the myriad user interfaces designed to access them contribute seriously to this problem. Physicians are often required to gain familiarity with numerous applications, and developers are similarly challenged to rewrite code to reproduce functionality. The advent of the World Wide Web (WWW) and the Common Gateway Interface (CGI) has made the process of data retrieval somewhat akin to the process of publishing a dynamic document. The web browser application provides a uniform and familiar user interface and enables the user ready access to review data.

However, no matter how intricate, web pages are still inherently static and data manipulation is clumsy. Additionally, each web site may have different layouts, color schemes, and organizational plans, features that reduce the utility of a simple site as a viable option for clinical record keeping. In particular, the problems posed by the stateless nature of the hypertext transfer protocol (HTTP) connection require that complex, rapid, and interactive data editing and entry be performed within a web-based application. A web-based application can be defined as a collection of scripted routines (JavaScript™, VBScript™), with or without Java™ applets or ActiveX™ components, contained within a web page.

The application so formed creates an environment inside the browser that can provide mechanisms to overcome the limitations of the stateless connection. Interfaces are being written for some of these legacy systems to allow web access by authorized users. The TICIS application are developed to simplify the creation of these interfaces by establishing a library of components that could be combined on a web page and function as an interactive electronic medical record (EMR). It was the application's objective to create a web-based application system that would result in the sharing and reuse of patient's record across large integrated patient database and provide a uniform, yet customizable web interface.

2.4.1 Electronic Medical Record (EMR)

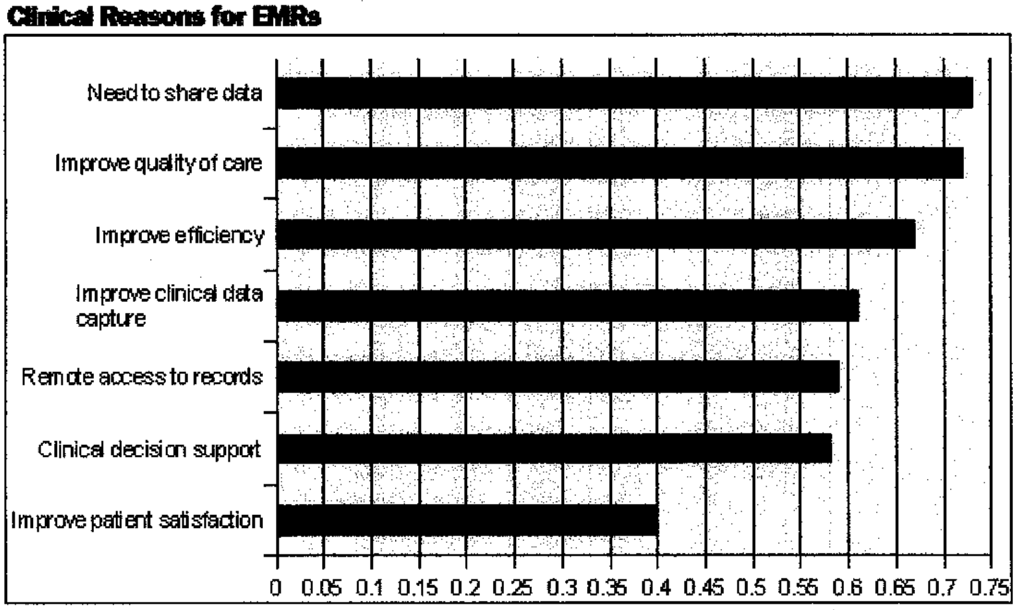


Figure 1: Clinical Reasons for EMR

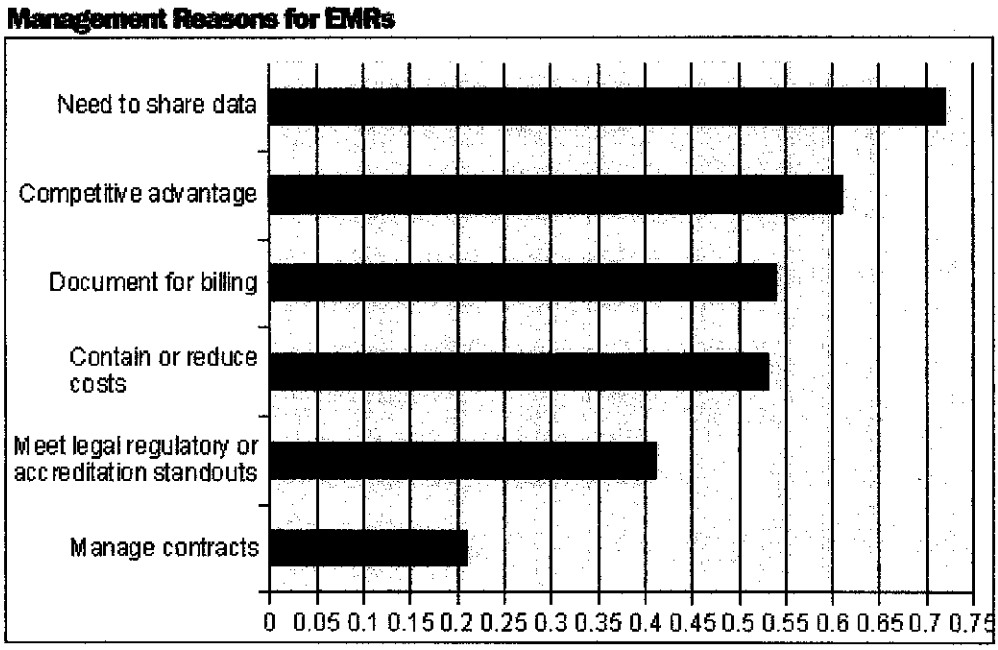


Figure 2: Management Reasons for EMR

From figure 1 and figure 2 above, it stated clearly the important of EMR both clinical and management perspective. The introduction of electronic medical records in this system afforded the possibility for records to be created, processed, stored, retrieved, and cross-referenced more efficiently. The electronic records of patients include all of the information stored in the paper-based medical record. It allows caregivers with appropriate security clearance to access patient's electronic medical records from any personal computer in the clinic. This feature eliminates having to locate the patient chart in order to obtain information necessary for treatment.

In addition, information can be easily sorted or grouped according to certain criteria such as the date on which the test was performed. The electronic medical record also allows the user to graph a set of results over time.

Not only does the electronic medical record system provide a central location for storing patient information, it provides several powerful functions that allow for better patient care. These functions were facilitated by the various components of the electronic medical records system.

2.4.2 Electronic Prescription Record (EPR)

The EPR contains all the data legally required to fill, label, dispense, and/or submit a payment request for a prescription. Pharmacists use the record to guard against drug interactions, duplicate therapy, and drug contraindications. Users can use the EPR to monitor utilization, provide prescription-labeling output, generate reports for auditing and quality reviews, and facilitates billing by claims processors. The information contained in the EPR facilitates communication between health care providers to improve clinical and administrative functions that result in improved patient care and customer service, while assuring value.

In time, managed health care systems will link the EPR with other medical record systems allowing prescribers to directly transmit prescriptions to the pharmacy of the patient's choosing. This integration of the patient's entire pharmacy and medical record will improve care through a process of total patient management. However, several physical and psychological barriers to the widespread use of electronic prescribing exist.

2.4.3 Electronic Patient's Registration Record (EPRR)

The EPRR is like any other electronic registration. When patients register first time at any clinic, the clinic administrative will key in all necessary info about the patients such as name, address, age, contact no etc into the system. The uniqueness of this registration is that patient will only need to register only once and when they visit other clinics, their record are already stored in the system and can be retrieve in seconds. They just need to present their medical smart card for verification and can go straight to the waiting list to be examined.

2.4.4 Pros and cons of paper, electronic and web-based medical records

Advantages of Paper-based Medical Records

- Flexibility of input
- Often dictation/transcription is fastest and easiest input method for physicians, especially for non-routine events
- Less initial start-up expense
- No special training required (beyond clinical professional training)

Challenges with Paper-based Medical Records

- Inflexibility of data retrieval
- Accessible only by one user in one location at any point in time
- Confidentiality - viewable by anyone in office
- Paper storage and transfer costs
- Legibility issues
- Handwriting legibility issues

Advantages of Proprietary Electronic Medical Records

- Accessible remotely (via a private network) and concurrently

- Increased legibility
- Comprehensive viewing capability
- Diagnostic/therapeutic problem-solving support
- Active automated reminders/tickler system
- Reduced time spent retrieving records
- Reduced costs of paper storage/transfer
- Confidentiality maintained through password-protected access
- More private than paper or web-based systems (data is stored on private server and accessed through secure channels)
- Patterns (within a record, across records) more easily identified supporting earlier detection, population comparison, trend analysis
- Can reduce redundant testing
- Reduced reliance on patient to provide medical history
- Templates enable data storage, sorting, correlation and retrieval
- Typically more robust functionality than available through web-based systems

Challenges with Proprietary Electronic Medical Records

- Lack of universal patient/provider/facility identifier
- Lack of universal vocabulary for clinical findings (history & physical)
- Lack of coding standards necessary for modeling strategies and query languages
- Lack of an underlying conceptual data model (database schema)
- Free text input is often slower than dictation and impairs data mining, yet structured documentation is inflexible and can limit differentiation of clinically relevant details while increasing "noise"
- Selection trees in decision-making hierarchies become too large (unwieldy)
- Coding and keeping textual medical knowledge current are costly
- Often more costly (to purchase and support) than more flexible web-based systems

Advantages of Web-based Electronic Medical Records

- Allows multimedia (graphics, images, video, sound)
- Input by voice, type, scanning, etc.
- Flexible integration with other systems
- Hypertext links to guidelines, journals and other knowledge sources
- Inexpensive/free browsers
- Centralized repository for trend analysis
- Navigation and viewing mechanisms usually more adaptable and easier to use than proprietary systems
- Accessible from various devices and locations
- Can be displayed on various types of user systems
- Patient-centric for optimal longitudinal care
- Can offer universal resource identifier

Challenges with Web-based Electronic Medical Records

- Security and privacy risks (unauthorized access, unauthorized linking with other records such as employment data, inappropriate use by secondary parties)
- Less robust functionality than most proprietary Electronic Medical Records (mostly charting, not reminders or interface with other software)
- May be less technically reliable (if data is stored on a server you don't own)
- Response time may be slow, or there may be constraints on number of concurrent users
- Because it is patient-centric, questions of data ownership and liability may become more complex

2.5 The future of healthcare systems

Extrapolation of current trends is a poor way to think about the future, particularly at times of great change. The best method, according to Ian Morrison, former president of the Institute for the Future in California, seems to be to bring together a diverse group of people knowledgeable about the subject of interest, provide them with good data, and ask them to imagine a series of possible scenarios. Earlier this year Andersen Consulting, the world's largest management consulting firm, invited 25 people from different parts of health care and from 10 countries to Singapore to consider how the world's healthcare systems might develop

Although every healthcare system is different, they can be grouped into four "archetypes." Socialized medicine (as in Britain or Sweden) covers everybody, has a single payer, and usually has those who provide care salaried or capitates (paid so much for every person for whom they provide care). Socialized insurance (as in Australia, Canada, or France) also covers everybody and has a single payer but pays those who provide care a fee for each service. Mandatory insurance (as in Germany, Brazil, Japan, Malaysia, and Singapore) again covers everybody but has multiple sickness funds or insurance carriers and provides care through a mixture of salaried public providers and private providers paid a fee for each service. Voluntary insurance (as in the United States or South Africa) does not offer cover to everybody and has many payers and providers and different systems of payment and delivery.

No healthcare system in the world is stable, and everybody at the meeting thought that all systems would undergo considerable change in the next 10 years. The drivers of change in the developed world are reaching the limits of the welfare state, exhausting traditional methods and tools for containing cost, and experiencing increased consumer sophistication and demands. Change is being driven in the developing world by the growth of the middle class, greater demands from that middle class, and the globalization of economies (as those countries are more exposed to what the developed world has to offer and experience greater competition and economic pressure within their own economies).

The group was able to imagine six future healthcare systems. The first was socialized medicine but with increased incorporation of the tools of managed care (Britain's NHS already includes many of these--such as capitation and gate keeping--and is in many ways one giant managed care system). The new tools that will be introduced include those used for managing demand–for example, advice lines to patients, user fees, and consumer education. Socialized medicine may also come to use the tools of medical management, including utilization review (doctors have to seek permission before referring patients or expending large sums of money), preadmission certification (approval by those paying the bills before a patient is admitted to hospital), and disease management (setting up systems to ensure more cost effective care of patients with chronic diseases). Managed care also has tools for the delivery of care, including telemedicine and greater use of guidelines and non-doctors for managing patients. British and Swedish doctors may wince at the thought of these tools being introduced into their systems, but it is hard to see how governments desperately trying to contain public expenditure and meet the rising demands for health services will be able to resist them. The group also thought that countries with socialized systems would experience increased pressure for growth of private care.

The second scenario was of a "managed mandatory system" where multiple sickness funds were exposed to competition, merged, and linked together by technology into a "virtual single payer." This system–which might emerge in Germany and Japan–would also use the managed care tools of demand management, medical management, and care delivery.

The third scenario may apply in countries like Singapore that now have a per capita gross national product comparable to that of many developed countries but which spend only about 3% of their gross national product on health care. These countries are keen to avoid the "trap" of an insatiable welfare state and would prefer to keep their spending on health care low. Singapore, which is keen to encourage "personal responsibility," has mandatory personal saving for health care, and employees must pay for some of their health care out of their personal account. The government hopes that this device will discourage inappropriate use, but Singaporeans can go directly to specialists–and increasingly do. These countries are unlikely to be able to resist the pressure for increased health spending, but some of the tools of managed care may help them.

The fourth scenario is of a multitiered health service with private, fee for service medicine at the top; American style managed care funded from social insurance in the middle; and lower quality, government funded care at the bottom. Some predict that all health systems, including that of the United States, will converge to this model, which is seen commonly in Latin America.

The fifth scenario described a system very different from anything that exists now–"an integrated and virtual" system. This system has been foreseen by forums organized by Andersen Consulting in Australia and may be brought about by new entrants to health care and by transformational use of information technology. The new players include corporations like Disney and Microsoft, which have very different ideas from existing players on how health care might be delivered. The Australians saw four futures: one where new players and transformational technology were resisted, two where only one or the other flourished, and the final one where both flourished. They opted for the integrated and virtual system, where both flourish, because they could not see these forces being resisted– but is not clear what the system may look like. They imagine that services will be provided "anywhere, anytime" by healthcare providers, suppliers, funders, insurers, and consumers working in new sorts of organizational relations. Government will become a regulator rather than a provider. Providers will focus on long term relations, and the consumer role will be much greater than now. This integrated and virtual system could operate within more familiar systems, including with a system like an enhanced NHS.

The centrality of consumers is the main characteristic of the sixth scenario–"the informed consumer." This is a form of health care that might operate within any other system. Consumers will use information technology to access information and control their own health care, consulting professionals much less often. Figure 1 shows how "information age health care" inverts the traditional pyramid of "industrial age medicine." Instead of being viewed as the apex of a system of care that hardly recognizes the large amount of self care that occurs now, professional care will be viewed as the support to a system that emphasizes self care. Healthcare providers will progress in this world from managing disease to promoting health, and they will do this through lifetime plans that are built on intimate and detailed knowledge of customers.

Perhaps none of these scenarios will emerge, but some of the developments imagined within them probably will. Doctors think that they have been living through years of uncomfortable change, and they have. But the pace of change is unlikely to slow, and our health systems will probably see more changes in the next 20 years than in the past 20. Most large sectors of developed economies–transport, manufacturing, and telecommunications–have been transformed in the past 20 years. Health care has not but surely will be.

CHAPTER 3
METHODOLOGY

3 METHODOLOGY AND PROJECT WORK

3.1 Waterfall Model

System development methodology refers here to the framework that is used to structure, plan, and control the process of developing this project. Building a web enable application based on existing process standard to ensure reusability with open source technology leaves the student with a fairly straight forward overall project development life cycle methodology. However, limited technical capability and interdependencies of various different programming language and technology requires ongoing internal testing and peer review of the different module to ensure usability and compliant to requirement and scope. Therefore the student would like to apply Waterfall development model to allow constant review upon completion of each stage of and repetitive development and testing process of the modules. The project also aim to deliver a reusable web application module with limited customizable interface layout to allow organization to reuse the module and change the layout and overall design to reflect their organization identity

The waterfall model is the classical model of development for both hardware and software. This model is frequently called the conventional model. The project is expected to progress down the (primary) path through each of the phases (requirements, design, coding and unit test, integration, and maintenance) of development, with deliverables (software requirements specification, design documents, actual code and test cases, final product, product updates) at each stage.

Work products (called deliverables) flow down the primary, stepwise path of normal development. The reverse flow represents iterative changes applied to a prior deliverable, the need for which has been only recognized in the next phase or even later. This is a natural consequence of the uncertainly associated with all development activity. Such changes are called rework and will require that not only some portion of the prior phase be repeated but the current one as well.

To begin with, student plays the role of the knowledge engineer in defining problems and goals. This is achieved by soliciting the domain expert on the knowledge. Knowledge is both the understanding of the domain problem and the rules to solve it. In this case, the existing IEEE standard and student's supervisor as the domain expert will serve as the main reference in understanding the requirement and procedure. The next stage is design and module development. Knowledge engineer will represent the knowledge acquired in computer coding. The prototype is developed to solve problems in a small area of the domain and provide a test bed for preliminary design assumptions. Once the separated module has been implemented, the knowledge engineer and the domain expert are going to refine the system before integration of the module and final integrated testing.

Below is the identified system requirement for product development and implementation.

Specification	Type	Version	Licensing	Developer
Client Side Scripting	JavaScript		Open Source	Netscape
Server Side Scripting	PHP	4.0.5	Open Source	Apache Software Foundation
Web Server	Apache	1.3.20	Open Source	Apache Software Foundation
Relational Database	MySQL	3.23	Open Source	Enterprise Linux

Table 1: System Development Requirement

3.2 Significances of Waterfall Model

- Helps minimize planning overhead
- Works well when quality requirements dominate cost and schedule
- The single requirements phase encourages specification of what the system is to do before deciding how the system will do it (i.e. specification before design)
- The single design phase encourages planning of the system structure before building the components (i.e. design before coding)
- The use of reviews at the end of each phase permits acquirer and user involvement
- The model permits early imposition of baselines and configuration control
- Each proceeding step serves as an approved , documented baseline for the succeeding step
- Many parts of the waterfall model are designed to reduce the risk of costly rework from a latent defect.

3.3 Waterfall Model Phases

The project development model consists of six distinct stages, namely:

1. In the ***requirements analysis*** phase the problem is specified along with

   The desired service objectives (goals) – The first activity in the requirements planning phase is to identify objectives of the application or system and to identify information requirements arising from those objectives. So, for this enhanced system, the first development activity is to acquire requirements on the existing prototype. This stage involves the understanding of the content and nature of the requirements of the existing prototype. At this stage, the objectives of the project will be the guidelines for the student in developing the desired prototype where it will answer all the problem statement identified in the project. In this phase, what the developer did was to find out what actually users expect from and by using this system. Physically this phase involves interviewing some users and discuss about the issue besides collecting data from the questionnaire. The data collected than eventually written down, so that the objectives of the project are stated clearly.

(b) The constraints are identified

2. In the ***specification*** phase the system specification is produced from the detailed definitions of (a) and (b) above. This document should clearly define the product function.

3. In the system and software ***design** phase*, the system specifications are translated into a software representation. The software engineer at this stage is concerned with:

- Data structure
- Software architecture
- Algorithmic detail and
- Interface representations

The hardware requirements are also determined at this stage along with a picture of the overall system architecture. By the end of this stage should the software engineer should be able to identify the relationship between the hardware, software and the associated interfaces. Any faults in the specification should ideally not be passed 'down stream'

4. In the ***implementation and testing*** phase stage the designs are translated into the software domain. Testing is also called quality assurance (QA); it includes not only unit tests, but also *integration tests* that exercise a subsystem or the entire system:

- Detailed documentation from the design phase can significantly reduce the coding effort.
- Testing at this stage focuses on making sure that any errors are identified and that the software meets its required specification.

5. In the ***integration and system testing*** phase all the program units are integrated and tested to ensure that the complete system meets the software requirements. After this stage the software is delivered to the customer [Deliverable – The software product is delivered to the client for acceptance testing.]

6. The ***maintenance*** phase the usually the longest stage of the software. In this phase the software is updated to:
   - Meet the changing customer needs
   - Adapted to accommodate changes in the external environment
   - Correct errors and oversights previously undetected in the testing phases
   - Enhancing the efficiency of the software

Observe that feed back loops allow for corrections to be incorporated into the model. For example a problem/update in the design phase requires a 'revisit' to the specifications phase. When changes are made at any phase, the relevant documentation should be updated to reflect that change. (Refer figure 3)

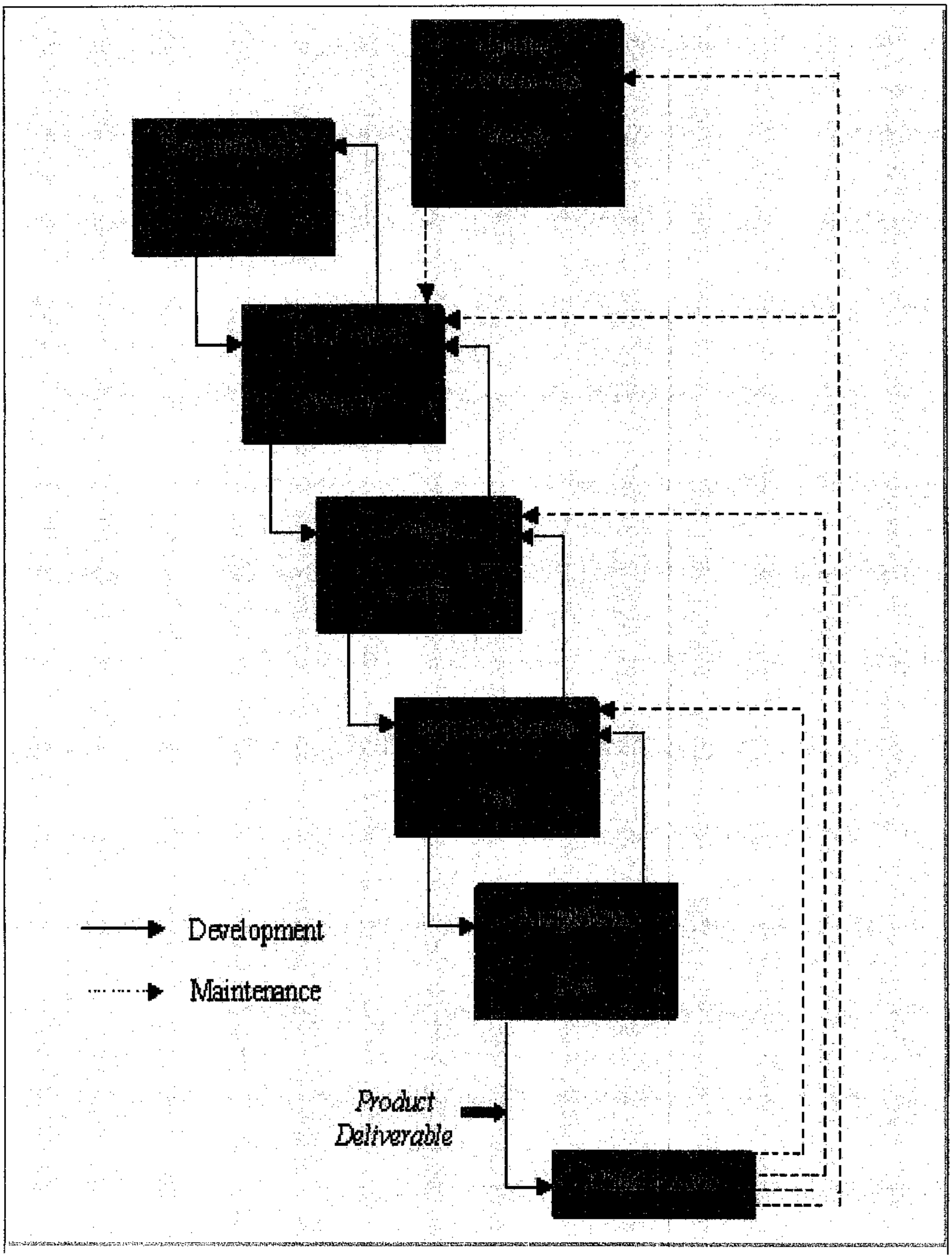


Figure 3: Schematic illustrating the Waterfall Model

3.4 Tools Required

3.4.1 Hardware Requirements

Suggested minimum requirement for development of this project will be:

- Platform – based application, which is Windows 2000
- 800MHz speed processor
- 256MB RAM
- 10.2 GB Hard Disk
- 40X CD-ROM
- Internet LAN connection
- 16MB of VGA
- Video and audio capture devices
- Networked computers (also with video and audio devices)

3.4.2 Software Requirements

These are several software needed to develop the application, any addition depends on situation

- Visual Basic.NET
- Macromedia Flash MX
- Macromedia Dreamweaver MX
- Fireserv 1.11
- Flax
- Adobe Photoshop 6.0

3.4.3 Server Side Scripting

A script is really just another word of program. It is just a set of instructions that take place automatically when a script is run. "Server side" just means that the control of the script is handled by the web crossing server rather than running a script on each user's personal computer. Web crossing runs the script and sends standard HTML (web pages) to each user's browser. All end user's browser has to worry about is displaying the result and the underlying script used to generate the web pages.

3.2.3.1 Personal Home Page (PHP)

In web programming, PHP is a script language and interpreter that is freely available and used primarily on any web-servers. PHP originally derived from Personal Home Page Tools, now stands for PHP: Hypertext Preprocessor, which the PHP FAQ describes as a "recursive acronym". PHP is an alternative to Microsoft's Active Server Page (ASP) technology. It is embedded within a web page along with its HTML. Before the page is sent to the user requested it, the web server calls PHP to interpret and perform the operation called for in the PHP script.

An HTML page that includes a PHP script is typically given a file name suffix of ".PHP", ".php3" or ".phtml". PHP can be thought of as a "dynamic HTML pages", since content will vary based on the result of interpreting the script.

In the development of IPIS system, 90% of scripting is using PHP including creating tables, form, database query and it combines with SQL query command.

3.4.4 MySQL

My SQL is an open source relational database management system (RDBMS) that uses Structured Query Language (SQL), the most popular language for adding, accessing and processing data in a database. Because it is open source, anyone can download mySQL and tailor it to their needs in accordance with the general public licences. MySQL is noted mainly for its speed, reliability and flexibility. It works best when managing content and not executing transaction.

MySQL currently runs on the Linux, UNIX and windows platforms. Many internet startups have been especially interested in MySQL as an alternative to the proprietary systems from Oracle, IBM and Informix.

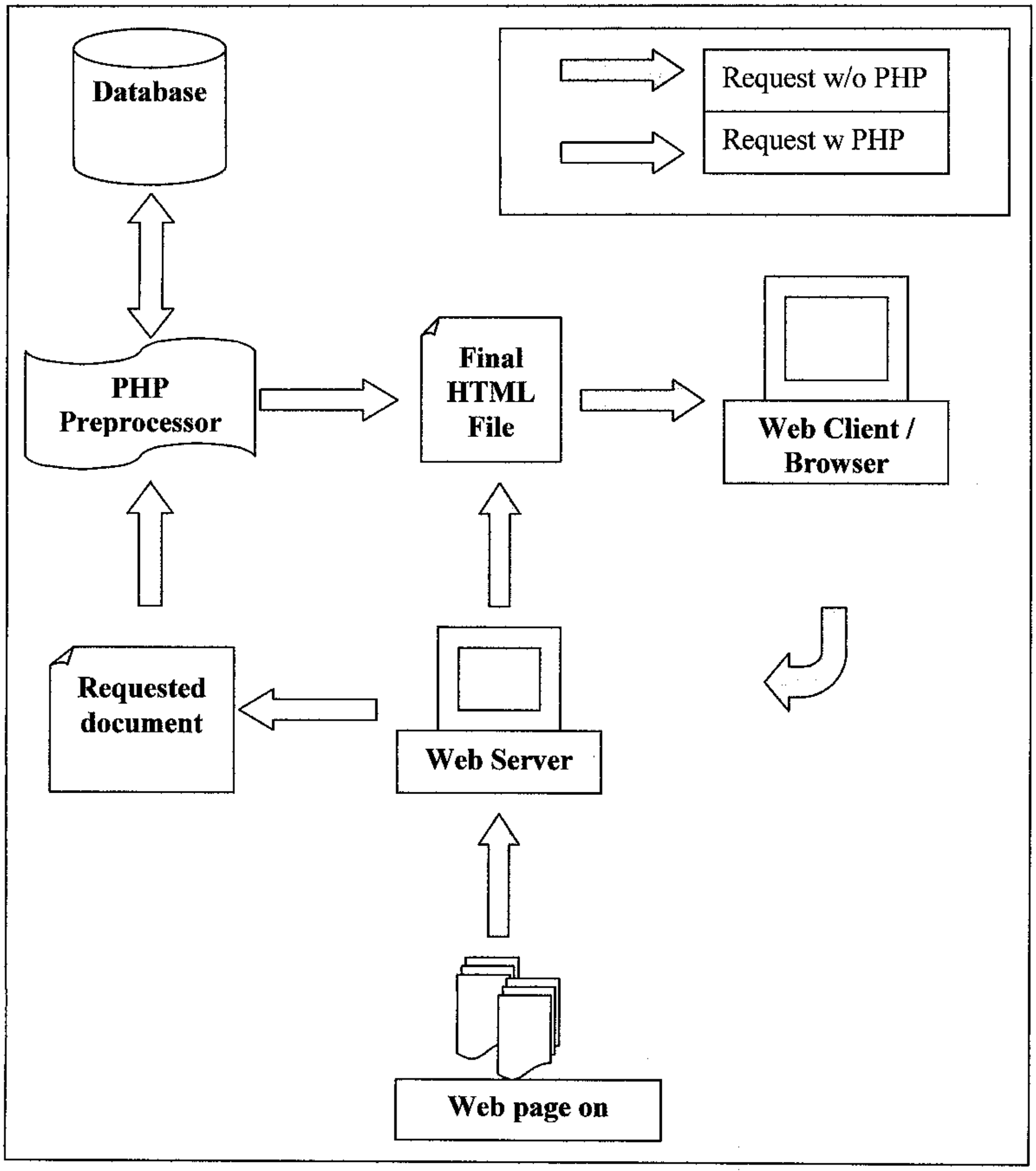


Figure 4: Interrelations between PHP and MSQL

CHAPTER 4
RESULT AND DISCUSSION

4.1 System Architecture

4.1.1 Architectural Design

In architecture design, the developer uses the system flow model in designing the system. The developer designed system architecture model which is adopted from the generic expert system. (The architecture consists of two parts; the first is the normal user system architecture where it indicated how systems work starting from the beginning of user site. The second part is the administrator system architecture where it indicates how administrator responds to the system and normal users. Both of these sites share the same database storage which only can be monitored and visible by the administrator. (Refer to Figure 5)

4.1.2 Concept Model of TICIS

Figure 6 show the new patient registration flow process of the Total Integrated Clinic Information System (TICIS). The registration starts with user log on to the system with using Staff Id and the password. The system then automatically loads all the information of the user within the pages. The user can view all the information including previous performance report and their schedule before making any request. The document involved is new patient registration form. User must fill up the form in order to complete the patient registration. All the details that have been filled up within the form is validate before saving to the database. The system will notify the user an error of saving data if the register patient's is already in the system. The completion of registration will add the patient's name into the waiting list before visiting the doctor for consultation.

Figure 7 shows the patient treatment flow process of the Total Integrated Clinic Information System (TICIS). The treatment starts with user click on the name of patient to be consulted. The system then automatically loads all the information of the patient from the database including personal profile and history medical record. The user is also able to view any digital diagnosis image included in the records. The document involved is new patient treatment form. User must fill up the form in order to complete the process. All the details that have been filled up within the form is validate before saving to the database. All information are then stored into the database and the treatment status including medicine prescription are sent to the pharmacy for processing.

4.2 User Interface Design

This system expects the users to be a diverse and dispersed group. So the developer makes this application compatible with Internet Explorer because it is ubiquitous and freely available. The developer uses a window-based design, which consists of multiple sub-buttons, shown in Figure 8. Each sub-button is associated with a Uniform Resource Locator (URL), which points to either a static file (a document in the Hypertext Markup Language (HTML) format) or a Common Gateway Interface (CGI) program somewhere on the Web. The specific function is determined by the developer of the sub-button; however, the HTML or CGI document to be displayed must appear in the current page, and subsequent files to be displayed (through links contained within the first document) must be displayed either in the same page replacing the current page, or a new browser window must be opened.

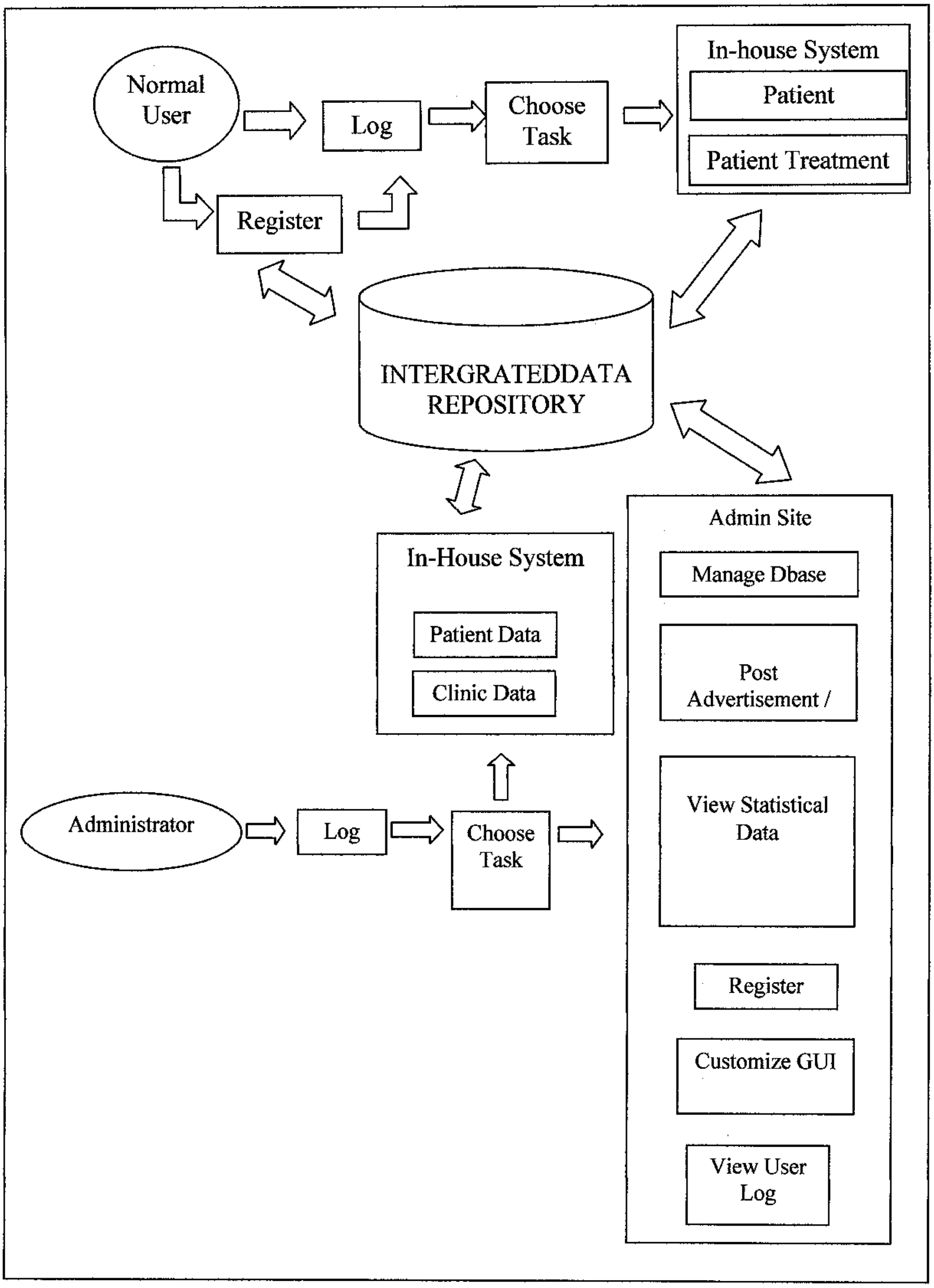


Figure 5: Total Integrated Clinic Information System (TICIS) Architecture

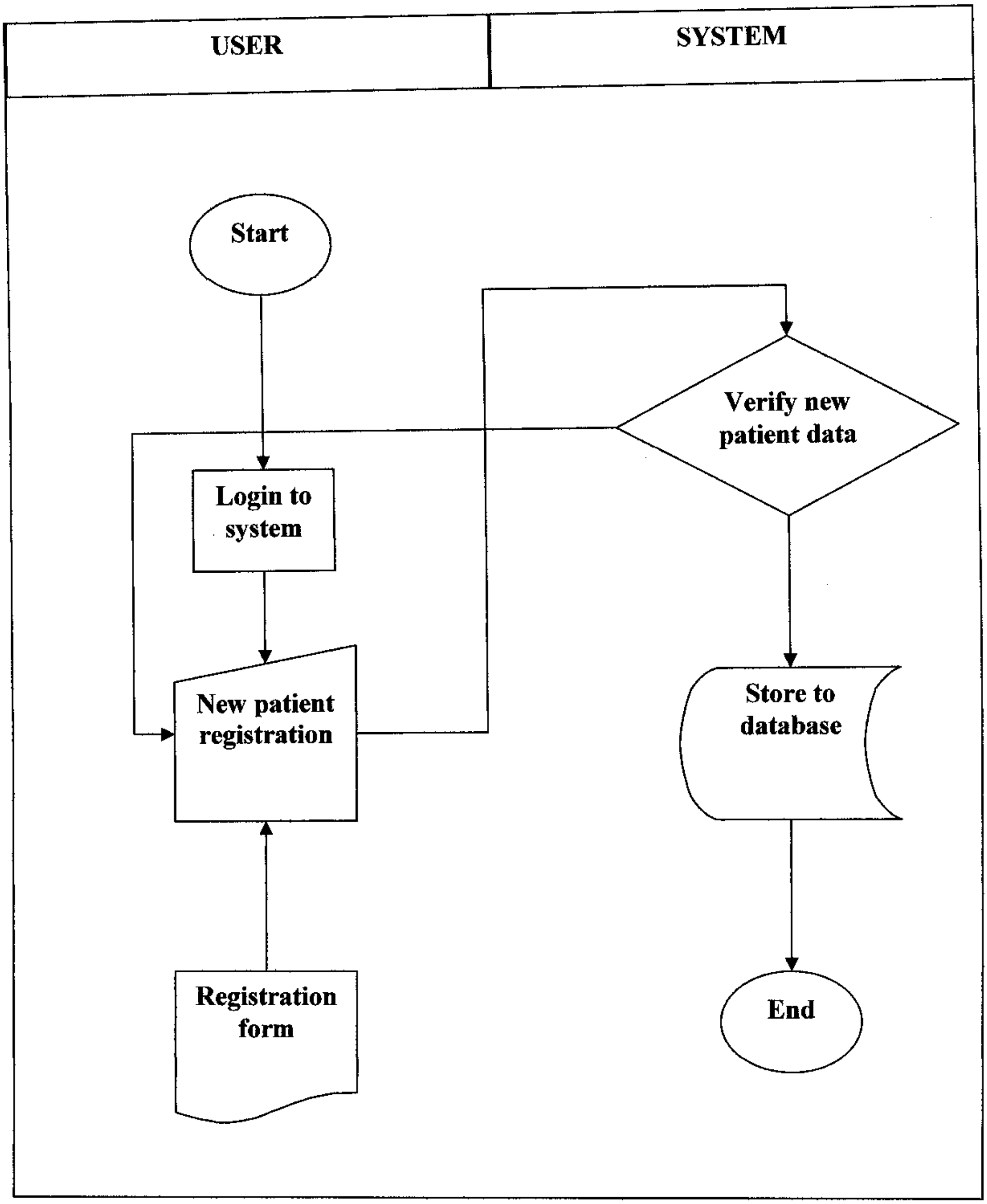


Figure 6: TICIS of New Patient Registration Flow

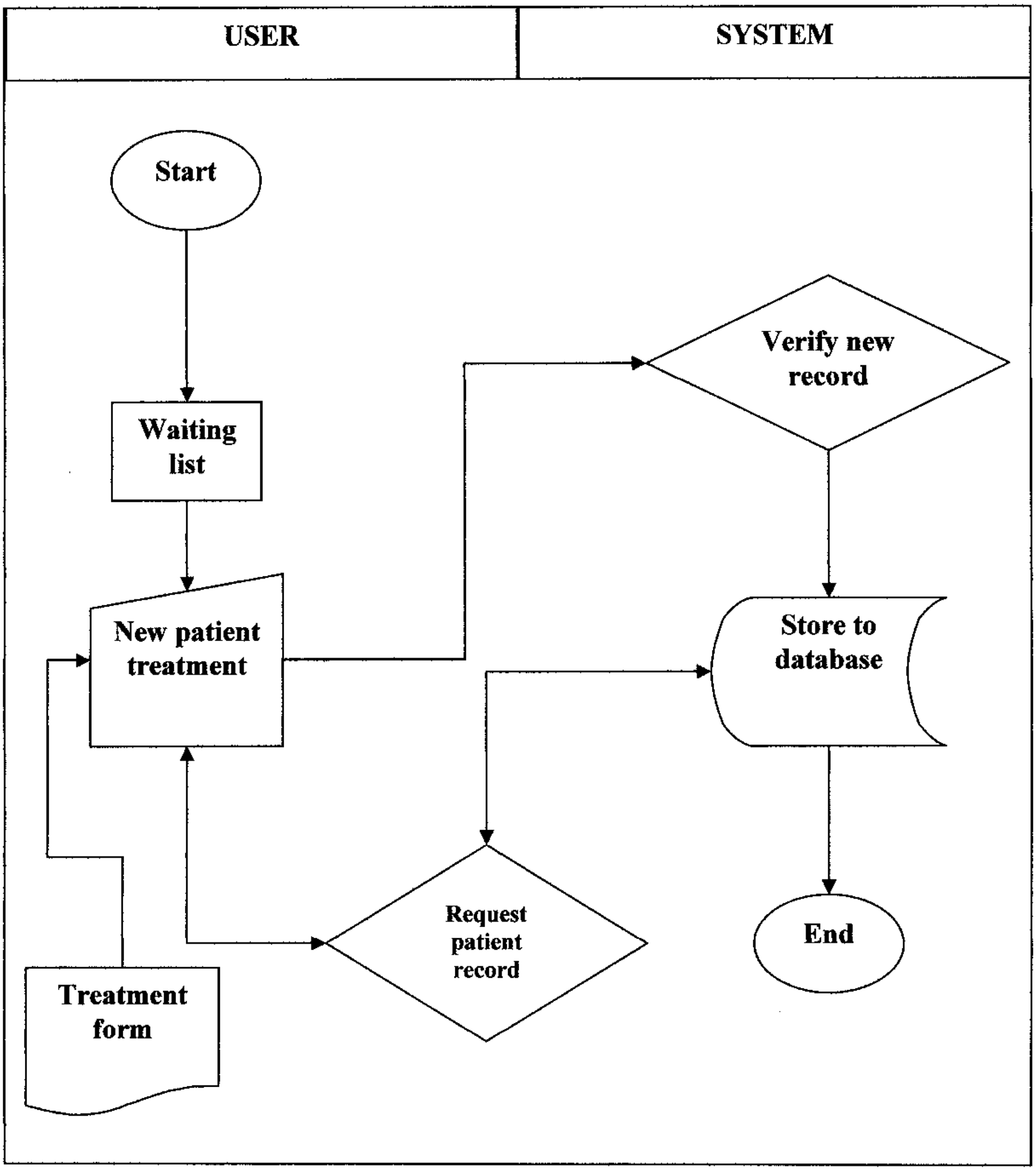


Figure 7: TICIS of New Treatment Record

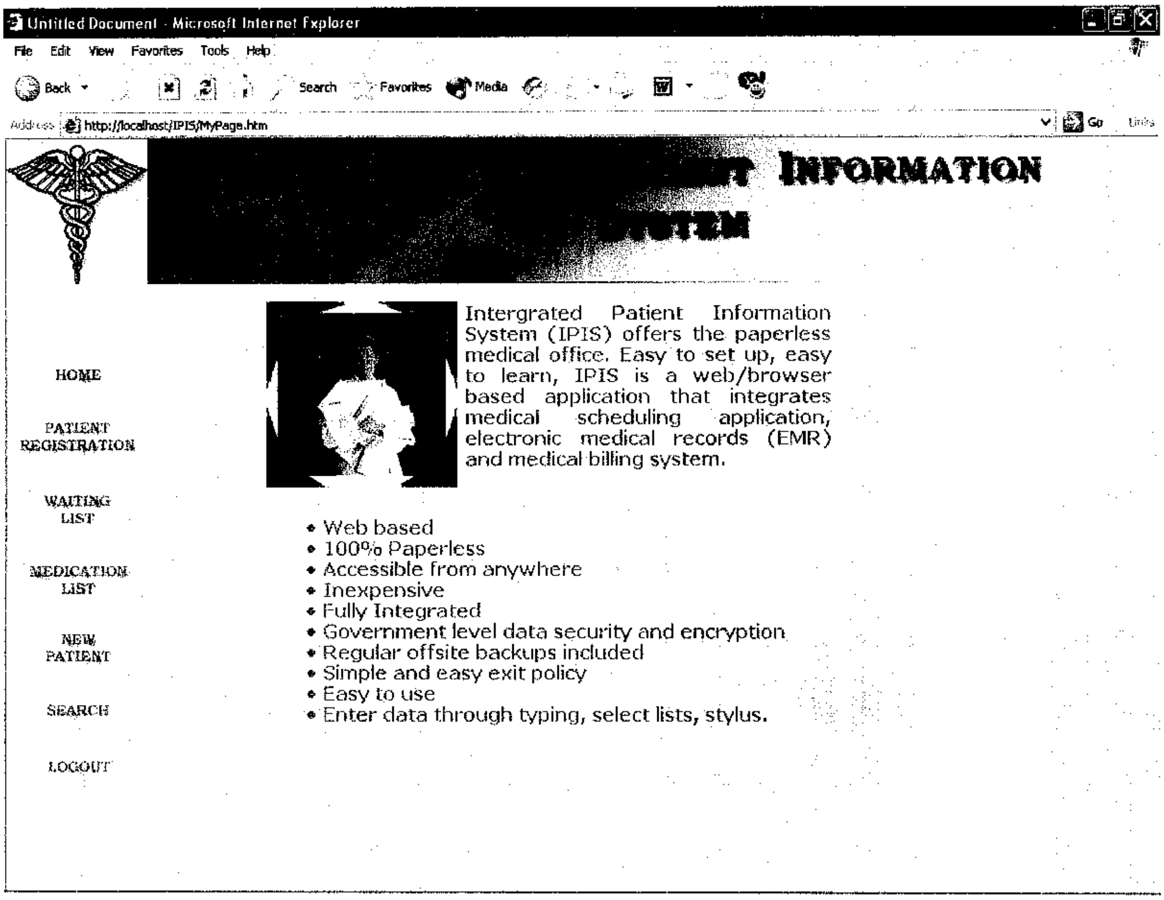


Figure 8: Sample of TICIS Screen

4.3 TICIS Storyboard

The system contain of 7 main page consist of login, index, treatment registration, waiting list, medication list, new registration and search page. This entire page is display within the same windows by clicking the hyperlink listed in the index page.

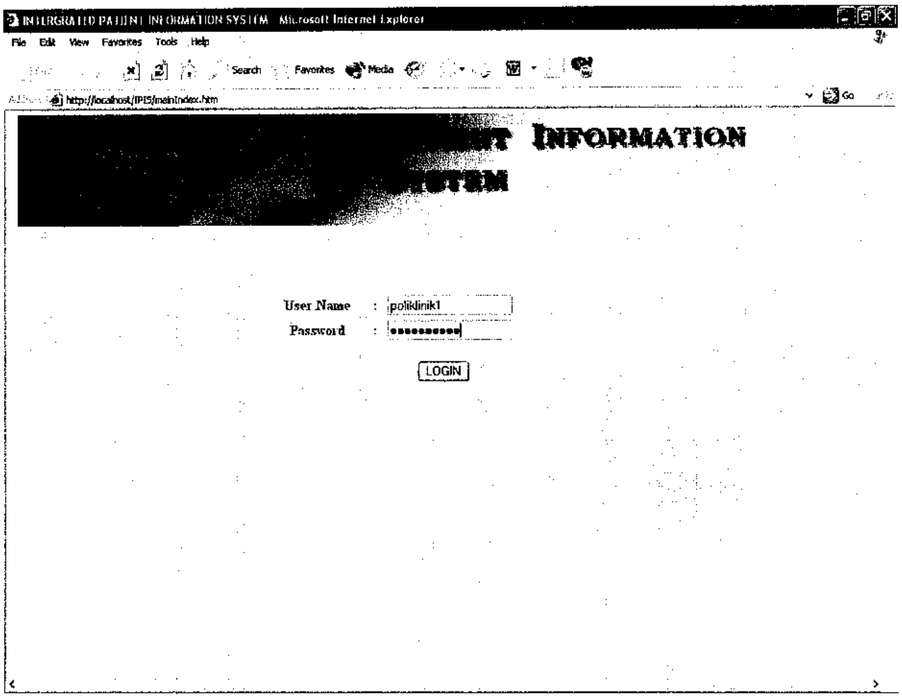


Figure 9: Login Page

4.3.1 Login Page

The page shown in figure 9 is the startup page of the system. The system will verify the username and password enter by the user with the values reside in the database. If succeed, the system will display the index page shown in figure 10.

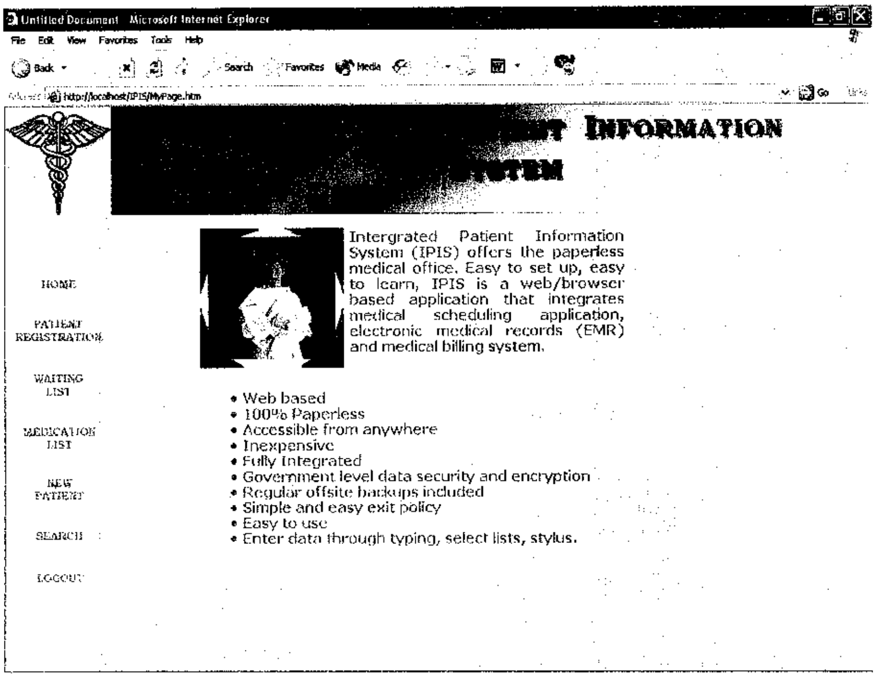


Figure 10: Index Page

4.3.2 Index Page

Figure 10 shows the index page of the system that will display if login success. At the left side of the page consist of buttons (figure 11) that will link to other page.

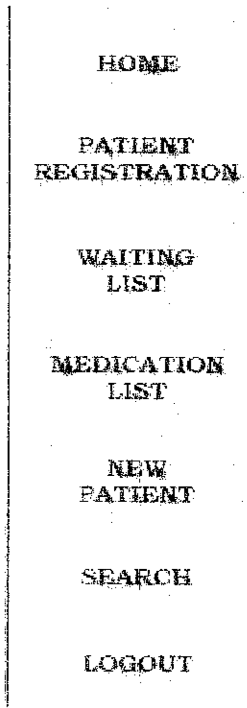


Figure 11: Menu Button

4.3.3 Patient Registration

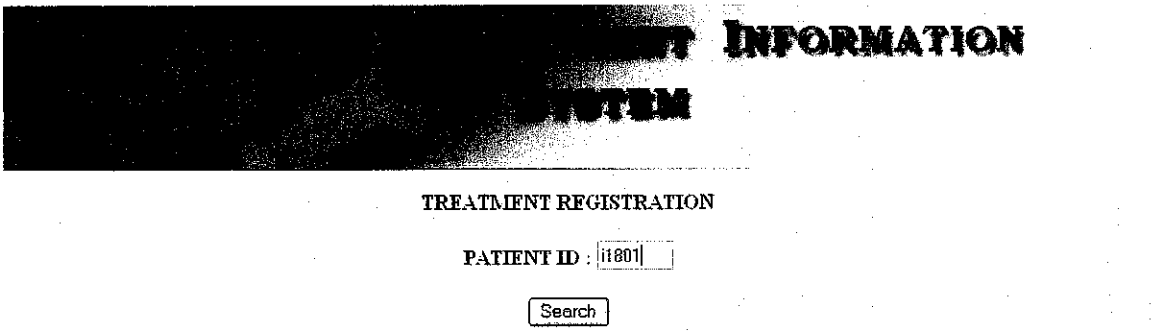


Figure 12: Patient Registration Page

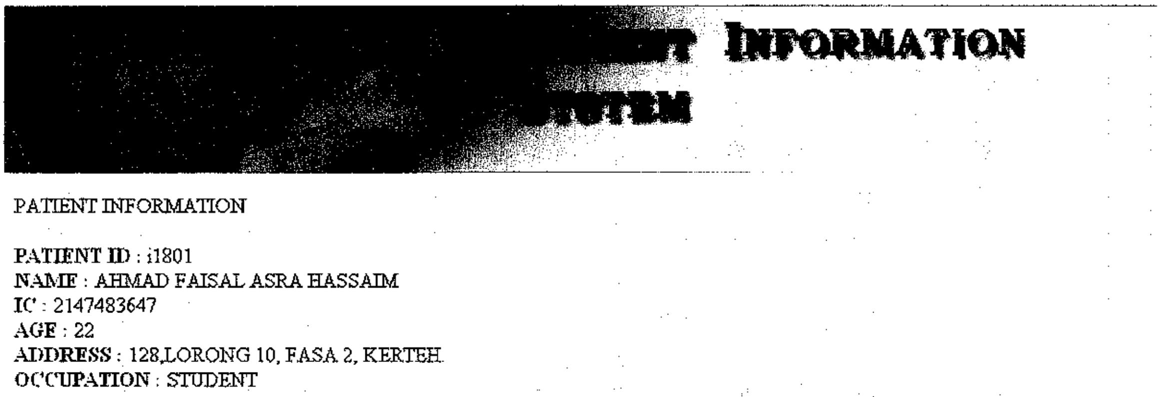
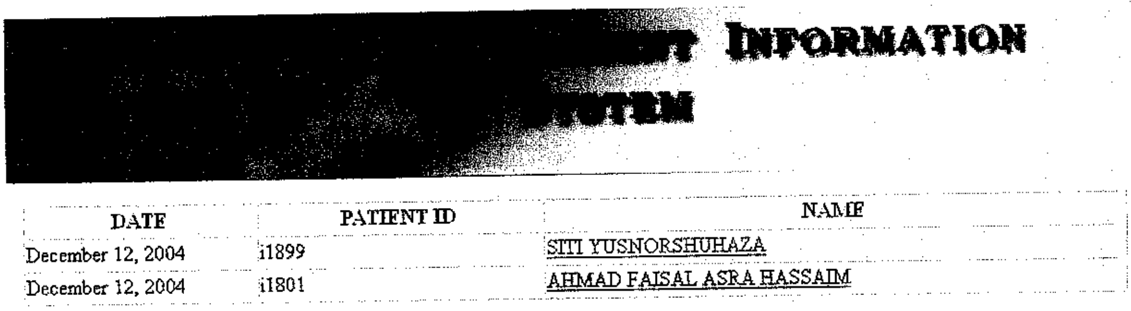


Figure 13: Patient Information Page

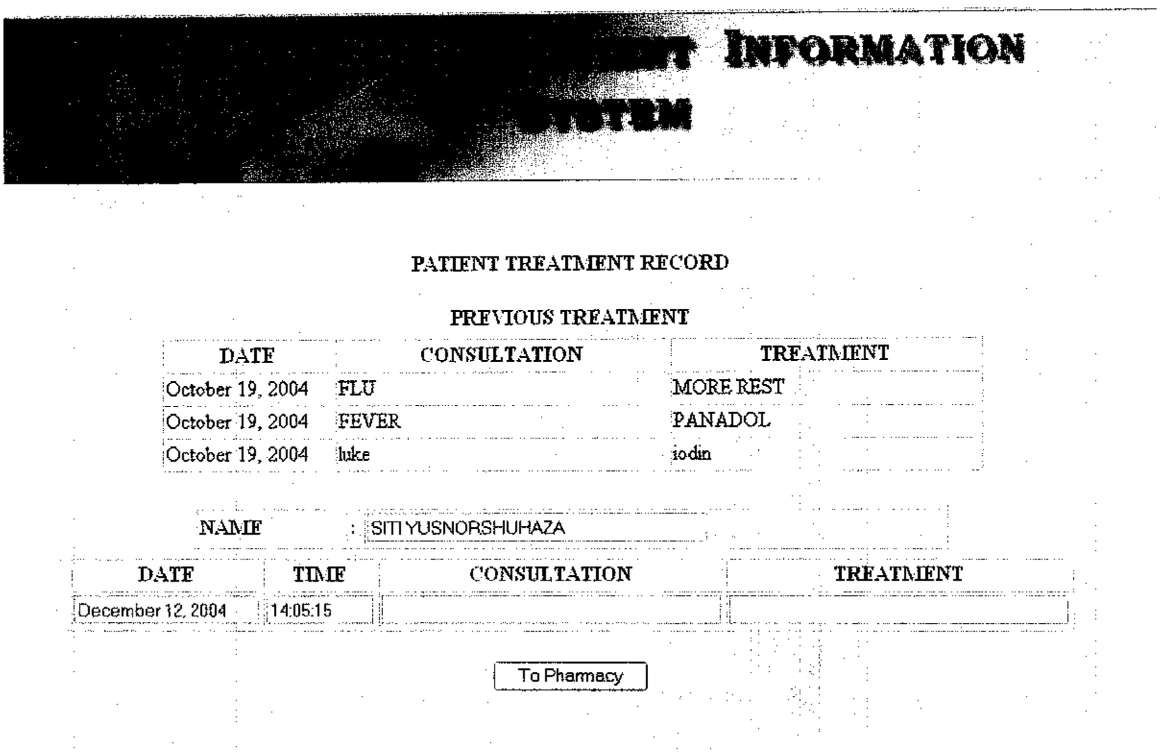
Patient id search page (figure 12) is display when "Patient Registration" button are click and once patient's id is entered, patient information page shown in figure 13 are display for confirmation. This page displayed general information about the patient to be consulted. When there is no search result, a new patient registration page (figure 18) will display for the user to create new patient database.

4.3.4 Waiting List



DATE	PATIENT ID	NAME
December 12, 2004	i1899	SITI YUSNORSHUHAZA
December 12, 2004	i1801	AHMAD FAISAL ASRA HASSAIM

Figure 14: Patient Waiting List Page



PATIENT TREATMENT RECORD

PREVIOUS TREATMENT

DATE	CONSULTATION	TREATMENT
October 19, 2004	FLU	MORE REST
October 19, 2004	FEVER	PANADOL
October 19, 2004	luke	iodin

NAME : SITI YUSNORSHUHAZA

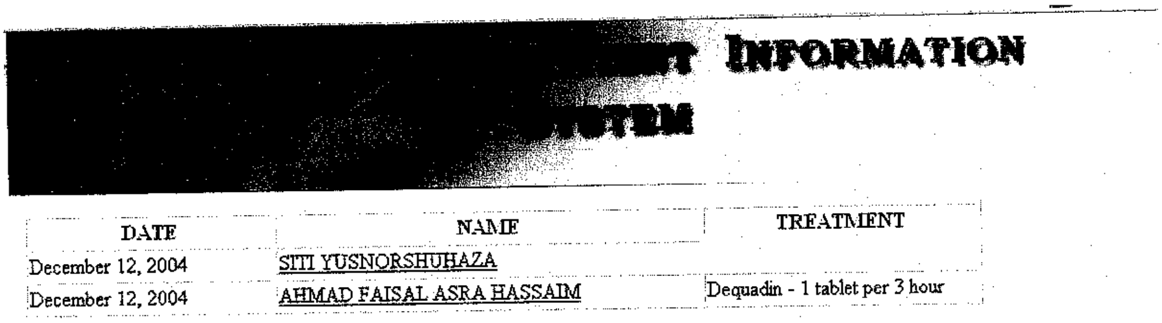
DATE	TIME	CONSULTATION	TREATMENT
December 12, 2004	14:05:15		

To Pharmacy

Figure 15: Patient Treatment Form

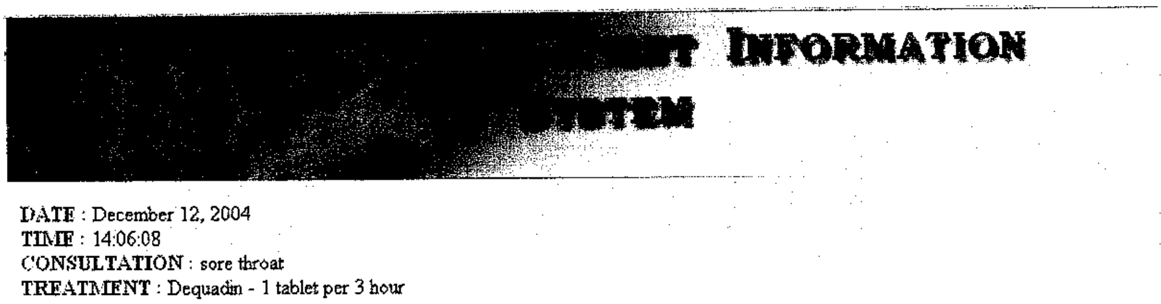
Figure 14 shows the patient's waiting list page where all the patients that are going to be consult are listed. When user clicks any of the patient's names, a treatment form page (figure 15) are display showing a treatment form and the previous treatment of the patient if any. The "To Pharmacy" button will end the treatment.

4.3.5 Medication List



DATE	NAME	TREATMENT
December 12, 2004	SITI YUSNORSHUHAZA	
December 12, 2004	AHMAD FAISAL ASRA HASSAIM	Dequadin - 1 tablet per 3 hour

Figure 16: Medication List Page



DATE : December 12, 2004
TIME : 14:06:08
CONSULTATION : sore throat
TREATMENT : Dequadin - 1 tablet per 3 hour

Figure 17: Medication Info Page

Figure 16 shows the medication list page that will display names of patient waiting for medication and figure 17 shows the medication information page displaying about the medication for the user to prepare for a particular patient.

4.3.6 New Patient Registration

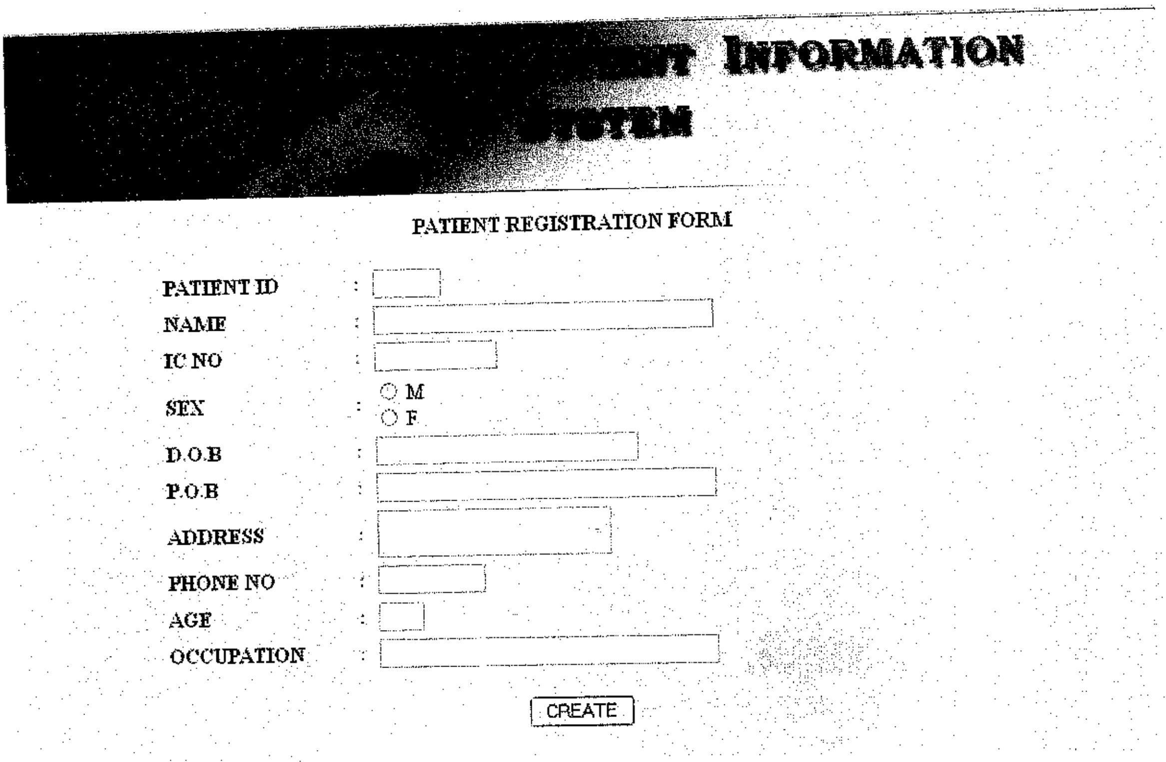


Figure 18: New Patient Registration Form

Figure 18 shows the new patient registration form for user to create new patient database. In this form, a unique patient ID is created to be used for patient identification. Once created, the patient just has to present their IC and patient ID at the reception counter for treatment.

4.3.7 Search Disease

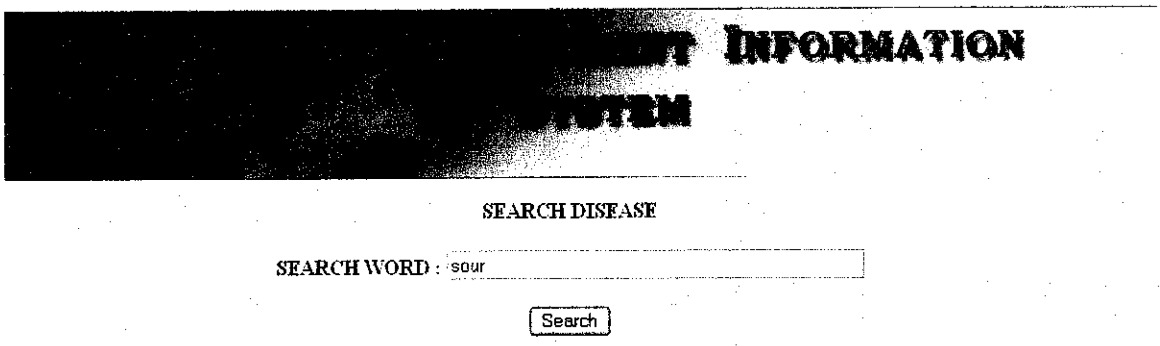


Figure 19: Search Disease Page

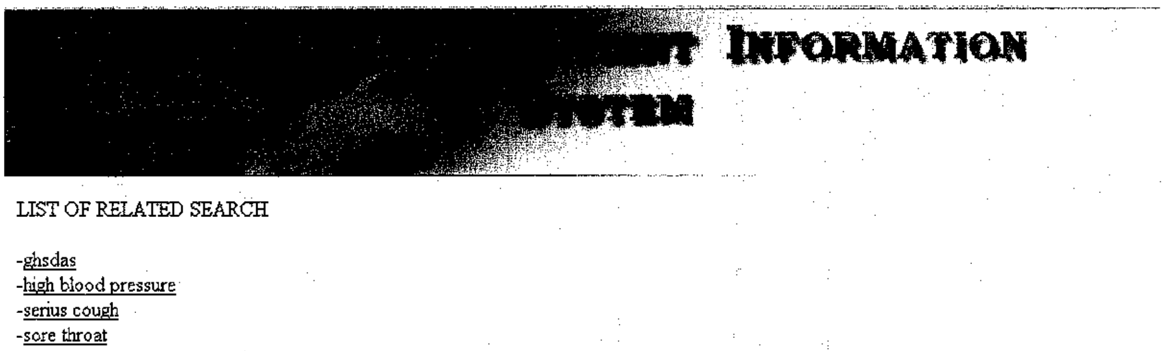


Figure 20: Search Result Page

Figure 19 shows the search disease page where user can search any disease information in the database and the search result will be displayed in a page shown in figure 20. More detail information about the disease can be viewed by clicking any of the related disease links.

4.4 General Requirements

This part describes general objectives and high-level specifications of TICIS. They are evaluated due to the special domains of medical records and the Internet.

4.4.1 Security

The protection of patient data is the most important requirement and should be handled with special care. If information about a patient is divulged negligent the damages for TICIS application and all the persons involved will be tremendous. Due to the fact that patient data is a very confidential issue, security is a very important subject that should be discussed in detail. The solution has to be secured guaranteeing patient confidentiality. But security is not a state; it is a process, which needs revision from time to time. That is why security checks should be routinely performed. Vulnerabilities exist in every application and invite hackers. Therefore continuous updates of all parts of the system have to be made. According to Albert R. Bakker and G. G. Griesser, security in a Medical Information System (MIS) is divided into three aspects of protection:

- Usage integrity
- Data/program integrity
- Availability.

4.4.1.1 Usage Integrity

Generally all chances of getting confidential information in an unauthorized way should be prevented in any case. The probability to access the data through an unsecured network requires a higher level of protection. According to ENV 13729:2000 of the British Standard Institution "the use of strong authentication with a cryptographic challenge-response method is required".

Secure Socket Layer (SSL)

In addition, the connection between client and server should be running under the HTTPS protocol if confidential information is concerned. It works in just the same way as the HTTP; the communication is only performed via a so-called Secure Socket Layer (SSL), for which an SSL capable server is needed. All the exchanged data are encrypted and no computer between the client and the web server is able to get to know which communication is taking place. But, of course, there are also disadvantages associated with HTTPS, otherwise all the communication in the Internet would probably use this ability. First of all there is the price. A digital certificate of a certifying authority such as http://www.verisign.com or http://www.thawte.com has to be acquired. This means high costs for each server it is running on. For a server outside the United States this will approximately be around US$ 400 per year. Additionally, much more CPU power is needed to encrypt and decrypt the data. This slows down the whole server as well as the client access.

Furthermore all passwords to the system should be hard to be guessed, continuously changed and kept secretly. Appropriate user guidelines need to be stated, and some rules should be checked automatically by the system such as the length of the password longer than 5 characters or the regular change of passwords. The retrieval of images or other patient relevant data should only be possible after a special security check. Bookmarks right in the middle of the system should not be possible since they make it easy to avoid authorization. Therefore sessions provided by the web server should be used. With SSL it is very difficult to manipulate a session. The application should always make a check against an active session before proceeding to any other task.

Cookies

Cookies should not be used because it is easy to read their information with the result that another computer can pretend to be the one that has originally used the cookie. Even if the password is encrypted in the cookie, the cookie in total could be stolen and abused.

All in all, it is an easy way to get unauthorized access and therefore cookies must not be used.

4.4.1.2 Data/Program Integrity

But it is not only the overall security that needs to be concerned about. The application should provide a security mechanism to also avoid loss of data or wrong data. Since the data is an important part of TICIS and it is impossible to eliminate any possibility of errors, it is indispensable to have mechanisms to ensure a consistent data stock. Otherwise it might be the case that based on a false assumption an algorithm is returning wrong results which a doctor is then using for diagnostic help. Therefore the integrity of the data is very important. The two main sources of errors are:

- Wrong usage or programming
- Loss of storage systems.

Wrong Usage or Programming

To avoid wrong usage a distinction between different users and their rights on certain database objects is one possible approach and another one is the usage of database features. Data integrity is an important issue, which can be solved by a good program. The database should provide security mechanisms ensuring that neither a loss of images nor their manipulation can occur if the authorization is not given.

Loss of storage systems

Continuous logging and backup copies are a good way to ensure data integrity. But for an image dataset another aspect has to be considered here: its size. Since the database handles a lot of data (around 2 Gigabyte at the beginning) backup copies are not very easily made.

4.4.1.3 Availability

Normally a computer system used in health care has to be available for 24 hours a day, 7 days a week, since patient safety is the one and only objective.

4.4.1.4 Confidentiality

The patient's name and even the patient's ID should not be visible to users outside the clinic who are not involved in the treatment of the patient and not bound to confidentiality restrictions. So, if the patient's name is included in the medical record due to the format, a mechanism needs to be implemented to black out this information, extinguish it or make it unreadable by other means.

4.4.2 Reliability

Reliability is a major issue in medical applications, since they handle critical patient information. Normally the communication infrastructure of the clinic should be redundant and therefore fault tolerant. At least the system should be very reliable as far as security is concerned. A crash or an error should be handled in a secure manner. Confidential data must not be handed out in such a case.

4.4.3 Costs

Since the database was designed for daily clinical use, the cost would not be of highest importance. Robustness and redundancy would be more important issues. But since this is just the start of a project, the cost of the whole system is of greater importance, therefore free components – like open source ones - should be used where possible. A limitation of the use of free or open source software might only occur due to the need to keep the source code only within TICIS.

4.4.4 Performance

The performance of the overall system including database, web application, web server and Internet communication should be fast enough to get quick results. According to research projects from J. Nosila, D. Scobie, G. Justice, B. Clark, G. Ritchie, W.J. Weigl, H. Gnoyke, and P. Fisher, the time between sending the request and the arrival of the requested should be less than 3 seconds. At the moment, this time requirement only exists for the productive work of a doctor in the Local Area Network (LAN) of the clinic.

Since the medical records are the most important part of this application, it should be secure and fast to directly get the data that the user request. Retrieving patient data will probably be the bottleneck of the service due to the amount of transported data. Text file size is no problem for an inner clinic network where it will be displayed in about one second. But via Internet this is normally not achievable. With an average transfer rate of 20 KB/s, this patient data including web page images will be loaded longer. The searching time has to be added.

4.5 Internationalization

Multilingual support is getting more and more important. Due to the fact that Malaysia has four spoken languages (Malay being the official one, Chinese, English and Indian in addition) and the scope of the project implies a global use, the system should be able to support multilingual output and descriptions.

4.6 The Benefits of TICIS

4.6.1Clinical Efficiency

Patient safety is perhaps the best reason for a physician to consider implementing TICIS application. The ability to view a patient's complete medical history allows doctors to make the right therapeutic choice for the patient at the right time. Physicians, individually or in a multi-user scenario, have the ability to pick a medication and check to see if it conflicts with other medications the patient is currently taking. Having the immediate access to medical information can also improve patient care, allowing doctors to better inform patients about the treatment being given.

In addition to providing a complete medical history, doctors are alerted to drug contraindications. For instance, according to the FDA, a diabetic patient also diagnosed with congestive heart failure should not use the diabetes medicine metformin, as they can have an increased risk of serious side effects.

4.6.2 Administrative Efficiency

TICIS also provides significant administrative savings to the practice by improving office efficiencies. Consider the case of a 14-physician primary care clinic in Kokomo, Indiana. The practice similar to TICIS saved $4,734 per week per office in pharmacist and nurse time.

Beyond pharmacy callbacks, TICIS arms pharmacist with critical health care information in real-time. Pharmacist will have the capability to record and access patient progress notes, exam notes, diagnoses, and patient orders, allowing the user to generate records and capture charges. All of these components help reduce staff time, thereby allowing doctors and pharmacist to concentrate more on other aspects of patient care.

CHAPTER 5

CONCLUSION & RECOMMENDATION

5.1 Conclusion

The TICIS project is still in evolution, with a pilot trial scheduled to complete by the end of October 2004. The developers therefore have no experience with actual usage by patients. However, the developer has moderate experience with several Web-based clinical information systems and believes that the developer can now assess those aspects of the architecture intended to address the development requirements.

Integration of multiple components has been remarkably simple, with pieces contributed by ten different individuals thus far. However, the developer are exploring the ability of TICIS to collect documents it retrieves from the Web such that all links in these documents will be refer back to the database. Naturally, the developer believes that the user interface will be easy for patients to interact with. We will not know for sure until we have begun testing with real users.

When the developer do begin that testing, the developer believe, based on the developer experience with evaluation of other systems, that the information collected through questionnaires and usage logs will provide a large part of what the developer need for the assessment. The developer may find, for example, that different arrangements of main buttons and sub-buttons are appropriate for different users. If so, the architecture will permit us to customize the presentation simply by associating different configuration files with different users.

Security issues will always be an important consideration for TICIS. The developer is attempting to strike a balance between safety and convenience. For example, the developer has not chosen to add any security features to the users' browser machines, found in other implementations. Despite the risks, the developer believes that the Web environment is ideal for developing applications such as TICIS. New ways to solve old problems, and solutions for new problems, arise every day. The IPIA architecture appears ideal for exploiting them as they appear.

In comparison with other online medical system, the TICIS application is much thinner, and the database access and application logic are maintained centrally. This makes it much faster to implement changes, new features, and new database connectivity. Issues surrounding software distribution and versioning are removed. In addition, network security is implemented easily by using the built-in SSL encryption of the web server and browser. On the downside, implementing text update is not straightforward, and there are limitations in sorting, error-handling, and other client-side tasks.

Since the database system had already begun functioning on a web based application for viewing previous patient treatment, instead of just integrating the data, it allowed administrator to provide the user with a more comprehensive application which includes links into the database as a local search engine. Minor changes were required on the main interface, such as removal of the ability to select a different patient. These features are necessary only in a stand-alone system, but undesirable in the context of the larger TICIS-Web application. In addition, minimal work was needed to implement a secure system by which to pass the coded identifier to the security system.

As a conclusion, **"Total Integrated Clinic Information System"** will provide clinic staff with an extensive option for improving patient care. Not only it can be a powerful tool to aid clinical staff, the information in the record is more accurate as well as legible. This system will create paperless medical record in order to improve care for both current patients and future patients. Successfully linking clinical treatment plans with research protocol information provides valuable information when assessing the effectiveness of particular treatment plans. Research efforts can move forward more rapidly when data is collected in an efficient manner as is provided by the electronic record. In addition, human error is less of a factor than it was when data was collected manually from paper charts.

This system goal was to implement a system that not only met the healthcare organization's current needs, but would also provide support for a growing number of patients and clinical treatment plans. This system will maintain and organize all the information necessary to support clinical and research efforts, and also guides healthcare providers in their daily treatment of patients. All in all the new system is at the center of providing the best possible patient care and advancing treatment for future patients.

This project paper should keep updating and enhancing its content with more necessary details. Furthermore, the project workflow should be followed according to the timeframe given, so that it can meet all requirements of Final Year Project.

5.2 Recommendation and Future work

As in most software projects there are always plenty of details to be improved after the first test run of the system. Some of the following suggestions were made by user having tested the current version of TICIS, of which some are the ideas of the author. The suggestions are sorted into four groups listed in a priority order.

1. Comfort and security functions
2. Backend functions
3. Expansion
4. Maintenance

5.2.1 Comfort and security functions

- Investigate other (medical) record databases and compile a work with descriptions about them and how they solve certain aspects
- Direct folder access rights only for certain IP addresses. All others through Java Servlets.
- New surface with more graphics and less text
- Improved search functions based on the user feedback in the first testing

- Ability to upload a great number of images at the same time
- Calculation of the age of patients based on the year of birth and the current year
- Improvement of the navigation
- More convenient listing of images (have a preview of images with thumbnails)

5.2.2 Backend functions

- Usage of BLOBs to store images such as digital x-rays.
- Prevention of systematic download of data.
- Protection of IPIS and In-house data from going into other databases too easily.

5.2.3 Expansion

- Excel/Access import functions so that other data format can be read by this system.
- More integration of patient's details
- Integration with existing data collections.
- The system could be advanced by integrating other 3rd party application.

5.2.4 Maintenance

- Code walkthrough
- Analyzing and evaluating the statistics of the usage

Detailed research can be done on topics this project to enhance the system. More sophisticated IT infrastructure and software applications such as telemedicine, remote access and networking of clinic will facilitate further advancements in healthcare.

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APPENDIX 1: PHP Script

LOGIN

```
<?
if((!$user) | (!$password)) {
print ("Please Enter In THe Correct Name");
}
else {

mysql_connect("localhost","","");
mysql_select_db("password");

#assign username and password enter by user to a veriable

$user = $_POST['user'];
$password = $_POST['password'];

#sql statemnet to compare values enter by user and values from database

$sql = "select * from verify where pass = '$password' and user = '$user'";
$result = mysql_query($sql);
$num = mysql_num_rows($result);

# If Login Is Okay.

if ($num == "1") {
session_start();
session_register(Username);
$_SESSION['Username'] = $user;
header("Location:MyPage.htm");
}

# if login not okay, go to the main page and re-enter username and password.

else {
header("Location:mainIndex.htm");
}
}


?>
```

PATIENT TREATMENT REGISTRATION

```
<?php

 #if the form submitted, sql statement to get info form the database and display it.

   if ($submit) {
    include "connection.inc";
    if (!$name)
     printf ("Please fill up the filed\n");
    else {
     $sql = "SELECT * FROM $name";

     $result = mysql_query($sql) or die("sorry, $name is not in my database<br><a
href=\"RegistrationForm.php?vname=$name\">Click here to register<a>");
     $num = mysql_num_rows($result);
     if ($num = 1 ) {
      while ($myrow = mysql_fetch_row($result)) {
                        $sql2 = "INSERT INTO waitinglist (id,name) VALUES
('$myrow[0]','$myrow[1]')";
                        $result2 = mysql_query($sql2);
                        printf ("PATIENT INFORMATION </br></br>");
       printf ("<strong>PATIENT ID   :</strong> %s </br>", $myrow[0]);
       printf ("<strong>NAME :</strong> %s</br>", $myrow[1]);
       printf ("<strong>IC   :</strong> %s</br>", $myrow[2]);
                        printf ("<strong>AGE  :</strong> %s</br>", $myrow[7]);
                        printf ("<strong>ADDRESS   :</strong> %s</br>", $myrow[5]);
                        printf ("<strong>OCCUPATION   :</strong> %s</br>",
$myrow[8]);
       }
     } else

                  echo "sorry, $name is not in my database";
    }
   } else {
}
 ?>
```

DISPLAY PATIENT IN WAITING LIST

```
# display name of patients in the waiting list in a table form.
<?php
 include "connection.inc";
 $sql = "select * from waitinglist";
 $result = @mysql_query($sql, $connection) or die("Couldn't execute query");
 while ($myrow = mysql_fetch_row($result)) {
   printf ("<tr><td>$today</td><td>%s</td><td><a
href=\"TreatmentTest.php?GoToTreatment=$myrow[1]\">%s</a></td>", $myrow[0],
$myrow[1] );
          }
?>
```

DISPLAY PATIENT IN MEDICATION LIST

```
# display name of patients in the medication list in a table form.
<?php
 include "connection.inc";
 $sql = "select * from medicationlist";
 $result = @mysql_query($sql, $connection) or die("Couldn't execute query");
 while ($myrow = mysql_fetch_row($result)) {
   printf ("<tr><td>%s</td><td><a
href=\"viewMedication.php?GoToMedication=$myrow[1]\">%s</a></td><td>%s</td>",
$myrow[0], $myrow[1], $myrow[4] );
          }
?>
```

CREATE PATIENT DATABASE

#creating patient's database and value stored

```
<?php
    include "connection.inc";

        $sql1 = "CREATE TABLE $Pid (
                        id varchar(5),
                        name varchar(40),
                        ic integer(12),
                        dob varchar(40),
                        pob varchar(40),
                        address varchar(40),
                        pno integer(10),
                        age integer(2),
                        sex int(2),
                        occupation varchar(40))";

        $sql2 = "INSERT INTO $Pid
(id,name,ic,dob,pob,address,pno,age,sex,occupation) VALUES

        ('$Pid','$Pname','$Pic','$Pdob','$Ppob','$Paddress','$Ppno','$Page','$Psex','$Poccup
ation')";

        $sql3 = "INSERT INTO waitinglist (id,name) VALUES ('$Pid','$Pname')";

            $result = mysql_query($sql1);
            $result = mysql_query($sql2);
            $result = mysql_query($sql3);

     echo "Thank you! $Pname Database created and information entered.\n";

 ?>
```

DISPLAY SEARCH RESULT

#values are compared from database and result is display in a link view.

```
<?php

  if ($submit) {
   include "connection.inc";
   if (!$name)
    printf ("Please fill up the filed\n");
   else {
    $sql = "SELECT * FROM records WHERE Vtreat LIKE '%$name%'";
    $result = mysql_query($sql) or die("sorry, $name is not in my database<br>");
    $num = mysql_num_rows($result);
    if ($num = 1 ) {
     printf ("LIST OF RELATED SEARCH </br></br>");
                 while ($myrow = mysql_fetch_row($result)) {
                        ('$myrow[0]','$myrow[1]')";
                       $result2 = mysql_query($sql2);

      printf ("<strong>-</strong><a href=\"details.php?vtreat=%s&vmedic=%s\">%s
</a> </br>", $myrow[3], $myrow[4], $myrow[3]);

     }
    } else

                 echo "sorry, $name is not in my database";
   }
  } else {
 ?>
```