Name	: *Premjit Singh Dulku*
Matrix No	: *WET 98047*
Supervisor	: *Assoc. Prof. Dr. P. Sellapan*
Moderator	: *Mr. Chiew Thiam Kian*
Title	: *Integration of Smart Healthcare Information Systems*

mavaan

A Graduation Project presented to
The Faculty of Computer Science and Information Technology
University of Malaya
In partial fulfillment of the requirements for the
Degree of Bachelor of Information Technology

INFORMATION TECHNOLOGY
UNIVERSITY OF MALAYA
2001/2002

FSKTM's copy

ACKNOWLEDGEMENTS

I would like to take this opportunity to convey my sincerest and heartfelt thanks to the following people who helped me in various ways in my preparation of this proposal.

They are:

- **FSKTM UM** for creating this opportunity for me to work on a system of my own.
- **Assoc. Prof. Dr. P. Sellapan**, my supervisor, for pointing out several issues and flaws and in doing so strengthening my case.
- **Mr. Chiew Thiam Kian**, my moderator, who has extended me his help and guidance.
- **Kiran Dass & Saravanabavan** for the long extended debates regarding various issues surrounding software development tools.
- **David Ng Lin Tat** for the invaluable help in determining the feasibility of servers and their architecture.
- **Dr. Jagjit Singh, Dr. Tarlochan Singh and Dr. Bharti** regarding pointers on patient data confidentiality and etiquettes that surround the medical profession.
- Definitely, **my parents**, for all the encouragement and support needed.

Above all, **the Almighty**, for the mental clarity and physical ability in this preparation.

Table of Contents

5.0 System Implementation

6.0 System Testing

7.0 System Evaluation

List of Figures

List of Tables

Abstract

This project presents a Smart Healthcare Information System (SHIS), which hospitals and medical centers can use to improve their services. SHIS provides a set of integrated services and is web based. The system comprises of several modules, which include patient, insurance and billing, pharmaceutical, healthcare provider, and medical center information systems.

It also provides a data analysis system for analyzing medical data. With this system, hospital staff (e.g., administrators, nurses) can perform their tasks (e.g., retrieving patient information, recording diagnostic and treatment details) more quickly and efficiently. Patients can also use the system to view their records and make online appointments. The general public can access the system to obtain general information such as expertise available and information about upcoming events. The system incorporates security features, which allows only authorized users to access confidential information.

The project documentation contained herein encompasses the literature review and system analysis of the Integration of Smart Health Care Information System, or in short, IntSHIS. Lots of details has been put towards the software and hardware involved which includes reasoning as to why particular configurations are favoured over others, which are also mentioned. It contains technical details as well as some conclusions that have been reached after the study of the specified tools.

Without doubt, most of the information gleaned for this section was taken off various Internet articles as well as some books related to the project that was developed. All this explanation, be it on integration or interaction across different components, covers the 5 modules which are discussed and will be introduced under the introduction.

The methodology discussed is primarily on basic yet important software engineering principles. This would be applied throughout the development phases of the system, which includes system analysis, design, testing and so on. The method that is selected to develop and test the system too is mentioned here. The system design as well as the process taken to develop the system is covered in the sections that follows. This report then caps everything off with screenshots and short captions which would illustrate the final working system that has been developed.

Extensive research and background surveys have been done on all topics involved have been made prior to the commencement of actual coding and documentation. This has been done to ensure a higher level of accuracy in the designing process together with the elimination of redundancy occurrence. Furthermore, a better knowledge base to begin with was acquired. It is hoped that the reader of this thesis report obtains an informative yet enriching document regarding the system that has been integrated.

1. INTRODUCTION

1.1 Overview

The Integration of Smart Health Care Information System serves essentially as a medium of communication between the diverse functional sub systems in a medical center. The areas (sub systems) encompassed can be divided into modules that already exist but have to be integrated into a working environment that correlates with each other. The main topic of discussion and research here is the integration of the already existing modules and the unification of ideas through proper graphic, text and icon management and provide all this on the Internet and Intranet with particular levels of security depending on the nature of the individual accessing the information.

The modules that are to be integrated are as follows:

- Pharmaceutical Information System
- Patient Information System
- Medical Center Information System
- Health Insurance Information and Billing System
- Health Care Providers Information System

Another module is being developed right now and it's about patient data and an analysis of it, which is called *System for Analyzing Medical Data*. This module would allow user's especially health care providers to check the current trend in treatment and the category in which a particular disease has a high occurrence. This module might be integrated also based on the time it would take for it to be completed.

A Smart Health Care Information System would quite certainly be defined as an open system which provides the integration and communication to the outside, together with the inside of the domain of the medical center which also covers the flow of the information within the above mentioned precincts. This system would give access to all demographics pertaining the particular medical center. Thus, it would be created on a platform that is compatible to support multiple users and be able to help them achieve an effective information administration.

Utterly web based on an interface basis, the Integration of the Smart Health Care Information System (IntSHIS) facilitates the management of different hospital services by efficiently providing information on the fly to various people in charge of said services and people interested in the particular information. This paperless office effort virtually eliminates space constraints and manual efforts.

Above all, it also attempts to provide both a conceptual framework in which it would demonstrate the manner in which web applications could be fitted together as a practical inspiration for this emerging domain.

1.2 Objectives

- To integrate existing modules which communicates and work together to provide a wide range of information that is covered in the 5 main modules. This will be accessible from any main page of the modules through a proper listing of links.

- To recognise the health care providers as major user and thus ease the use. The greater the need to share data and functions by all health care providers, the more the need for integration and the better we achieve a cost efficient IntSHIS.

- To study and investigate the current Web information system, implementation together with developing tools and their relevance to the project.

- To fulfill the users need in terms of information.

- To guarantee the high availability of the system where the response time is fast and the confidentiality and reliability of the system is high. Proper deployment of the number and structure of the client-server system.

Some of the other general objectives are:

- The hope of placing, in particular the local medical center at par, if not better then the online services provided by their counterparts in other developed countries. In the wake of technology related services, medical centers can boast their grasp in this sector too by showing the determination of providing real - time information and better services at large.

- Availability of clear, reliable and concise information for;

1. Better patient cares.
2. Higher standard of care where real - time multi user access ensures up to date information.
3. A more transparent information system in which the detection of illegal manipulation of patient records would be rather easier.
4. Reduction in appointment delays.
5. Billing process and the insurance related payments will be online documented and less troublesome.
6. Up to date pharmaceutical related and relevant information.

1.3 Scope

The IntSHIS is mainly and almost entirely about integrating existing modules to a main system, which would relate dynamically to each other. Dynamic relates to the fact that dead-end pages will not exist. For example, an individual in the Patient Information System module/environment would be able to access the Health Insurance Information and Billing module/environment via their respective main pages. This could be done without the need of having to get to the main page of the IntSHIS.

The Integrated Smart Health Care Information System (IntSHIS) will be developed according to the following parameters.

- To create a uniform graphical user interface (GUI) amongst all the modules and the standardization of the usage of icons in order for the IntSHIS to be able to perform as one.

- A web-based interface would be developed with HTML coding and not ASP as the other modules so that it wouldn't be dependent on any servers to serve as the main page and as a primary method of communication between the user and the ASP pages of the other modules. Hence, communicating with the databases of the other modules.

- Web site maintenance access and a secure database will be provided to allow the system administrator(s) to monitor and update the environment of all the modules.

- The debate regarding the placement of the particular modules in one server or more to facilitate the overall functionality in the event of a server breakdown and the availability of other information will be answered. This is regarding whether one module would/should affect the other modules in the event mentioned above.

1.4 Significance

By using the conventional manual system to find our needed resource, process or administrate the medical records will neither be cost effective nor time-effective and informative nowadays since all this require spaces, time, and energy to handle the constantly expanding volume of data at an explosive rate. The demand for accurate and fast information is ever increasing in this era of k-economy.

The quality and outcome of public user can be improved through the web - based system ensuring the accurate, relevant, structured and timely information is made accessible to the appropriate personal at all levels. Furthermore, the web technology has been growing aggressively to play a significant role in the business world. Therefore, this IntSHIS will quite definitely be a considerable and important step to start off into creating a web-based medical center information system.

As a pioneer in Malaysia, this project is rather significant in creating that new administrative way of data managing and manipulation. This is perhaps the most important time to begin research and also improving foreign existing methods and algorithms of maintaining data and information within a database in a more precise and meaningful manner. This will help to boost and maybe change the way Malaysian medical center strategy works into a better and a more competitive one.

This is definitely together with the hope of some level of telemedicine taking place, and the avenue for improvement is present.

1.5 Expected outcome

The summary of the expectations of the outcome is as below:

- An acceptable amount of response time when one requests for a web page from the server.
- A user - friendly manner will be used to report an error regarding data input errors after being checked.
- The database of the modules can be easily upsized to more capable systems if the need for increased capabilities and functions arises in the future.
- Session object that is provided by IIS will help track the user's state and navigation flow.
- Standard graphic user interface will be used across all web pages and the multiple browser display will be sporting the same interface too.

- Simplicity will be the core feature toped with user - friendliness.
  1. A logical flow of searching will be as simple and direct without much twining to cater all levels of users in particular, Internet amateurs.
  2. The availability of simple search engines that aren't fancy and still delivers.

- Subscribed user will be notified through e-mail upon any new event update.
- The availability of a newsletter for the notification of latest update on events, activities and things pertaining the medical center.

2.0 Literature Review

2.1 Introduction

The development phase of a particular system can only be started once some accepted level of research and analysis has been done. The main objective is to acquire the basic and essential knowledge in order to be able to execute correct techniques and ways in the designing and implementation stages.

An extensive research is done in some predetermined area that would include:

For example,

- Web programming languages.
- Web servers.
- Web programming technologies.
- Databases.

Also regarding their connectivity with other systems, especially with the ones that have a larger market share.

Without doubt, the importance of a background research on existing systems too can't be sidelined which is crucial for determining the scope and extensiveness of the project together with project planning.

2.2 Research method

Numerous methods were used to acquire the relevant and appropriate information and also the proper exposure to existing online sites of medical centers and their scope of service. It has always been the way to look at existing systems and then improvise on them.

- Discussion with experienced personnel on their views of data confidentiality.
- Up to date information from the Internet keeping in view, the date the site was last updated.
- Finding the proper avenues at University Malaya Medical Center regarding patient data, this is highly confidential.
- Reading, learning and summarizing materials pertaining development tools for the project.

2.3 Survey

Much of the survey was done on foreign web sites since there wasn't any system of the IntSHIS category in Malaysia. It was mainly focused on the interface, its flexibility and the features provided. Comments on some of the relevant web sites that were visited and learnt about are as follows:

1. San Jan Jacinto Methodist Hospital System

(http://www.methodisthealth.com/sanjacinto/index)

This site stores their information in HTML. This makes updates and modifications troublesome to perform because data is inserted into a HTML file instead of implementing a server like the SQL Server. The site is rather slow. This must be because there is a lot of information on single page itself. The lack of proper data management is evident and it proves the importance of it. Therefore, it makes downloading time much longer.

2. Cape Fear Valley Health System

(http://www.capefearvally.com/link.htm)

This site's layout is just too plain. It wouldn't captivate the information seeker and shows not much thought have been put to designing it. Although the goal might have been to decrease downloading time tremendously, but a certain level of creativity should be present and not compromised with. The search criteria too is quite limited to a certain functions only.

3. Saint Barnabas Health Care System

(http://www.saintbarnabas.com/)

The first thing the user has to do has nothing to do with the probable reason of him surfing this page. The user is required to fill up some personal details before any further searching or surfing can be done. This could be summed up as time wasting as one has to wait for the pages to load and clear these few obstacles before being in the actual environment. The relevant functions encountered here are the health care provider locater and the Calendar of Events, which has been achieved by the other present modules. The flaw would be the inability of accessing patient information by the health care provider. Through interviews and discussion, I did find this subject to be that of a controversy with conflicting views. The health care center has to decide on this based on their governing rules, constitution and ethics.

5. Medpearl (Nashville, Tennesse)

(http://www.medpearl.com)

This secure and proven system is currently handling over a million patients data. This site provides the facility for the patient and physician to log in. Therefore, online update of data is made possible. Medpearl can literary save lives as it grants access to records particularly in an emergency. Access is granted to medical details from any part of the world because it's a web-based service for clinical and financial workflow.

Data integrity is taken care of by allowing only doctors to update the relevant clinical data. Lab technicians and nurses do not have access to them.

4. Baylor Health System

(http://www.baylorhealth.com)

As usual, the drawback is highlighted. In this case, it's the fact that the site doesn't display any news or events and the health care provider has no access to patient's records. It is a good site though, with heavy graphics, which inevitably caused the downloading time to slowdown. The search engine produces good results with proper and relevant data, which is because they are very informative.

The health care provider section of this module needs much more attention. Neither is the physicians' consultation time provided nor does the health care provider any access to patients' records.

2.4 Survey's summary

After much surfing and opinion seeking, it is rather true that there is yet to be a profound web-based health system that specializes in various fields especially by the ones that have been provided by the modules in the IntSHIS in Malaysia. More features that are new need to be added to improve and support the dynamic interaction between users and the web server. It has to be powerful yet high with dynamic interaction, informative and with a simple search engine.

Those sites that managed to measure up somewhere in this perspective were the ones that present information that are too general, limited and static. These sites hardly do users any good for those who search specifically for more specific medical information. The routing to the specified page is too long. A user has to make a few clicks in order to be able to enter a particular page. Some of the sites do not even post confirmation pop-ups, which would render the sites to be user-friendlier. These sites, unknowingly limit themselves to being just a mere indirect advertisement for the particular medical center in a different avenue.

Bearing all this in mind, it's important to develop a system that overcomes all this shortcomings and inconveniences to an acceptable and tangible extent. The reinvention of the system is rather timely and would be accepted with much anticipation.

2.5 Software Development Tools

2.5.1 Scripting languages

Scripting languages provide quite many dynamic capabilities. Scripting was introduced since Internet Explorer V.3 and in Netscape Navigator since V.2. The main difference between programming languages (PL) and scripting languages (SL) is that the rules governing the areas are less rigid with (SL) compared to (PL). This refers to syntax and rules of scripting too.

Scripting can be divided into two types:

- Server side scripting
- Client side scripting

2.5.1.1 Server side scripting

The web server interprets the server side scripting. A few of these technologies that are available are: ASP and CGI.

The following are the advantages:

1. It becomes browser independent.
2. Loading time is shortened.

3. Security is improvised. This is because the code is not visible (viewable) from the browser.

Active Server Page (ASP)

ASP is useful because it is browser independent Microsoft technology. It doesn't matter if the user is using Internet Explorer, Netscape Navigator or NCSA Mosaic, the ASP codes can generate HTML. Should here be specific differences amongst the different web browsers, which we would like to exploit too, information regarding the browser type can be obtained from IIS and it is possible to generate a different HTML page for each of the type recognized earlier.

It contains a set of instructions that are processed by IIS on the web server. In most cases, the ASP code returns the result of the server side processing by dynamically generating a HTML page. The combination of scripting language, programmatic accesses to ActiveX components and the ability to generate HTML on the fly makes ASP a powerful technology for building dynamic web sites. It supports, supplies scripting engines for VBScript and JavaScript.

It works by allowing the developer the functionality of a programming language. Thus, the developer is able to write a programming code that will generate a HTML page successfully albeit dynamically. Therefore, when a user requests for an ASP page from a particular web site, the server would process the ASP code at that time. This processing generates HTML, which is subsequently passed to the browser and used to create the web page itself. This proves that ASP generated content is compatible with standard, current browsers.

Common Gateway Interface (CGI)

CGI is a web server scripting standard. It's not a program or script but a mechanism for managing interaction between the web server and the browser. In the past, most CGI programs were actually script files written in scripting languages like Perl. Now, scripts can be executable programs, such as scripts in C and Visual Basic.

However, CGI does have some disadvantages. The major one is that it adds an extra level to the browser-server model of interaction. It's necessary to run a CGI program to create the dynamic page, which would be sent back to the server. Moreover, many programming languages do not manipulate the receiving and transmitting of CGI codes.

2.5.1.2 Client side scripting

As stated earlier, the server side scripting is handled by the web server. In this case, client side scripting denotes to the fact that the script is interpreted by the browser. The popular names that one hears regarding this are VBScript, JavaScript and Java.

The following are the advantages:

1. As the script is interpreted by the browser, the following are achieved:

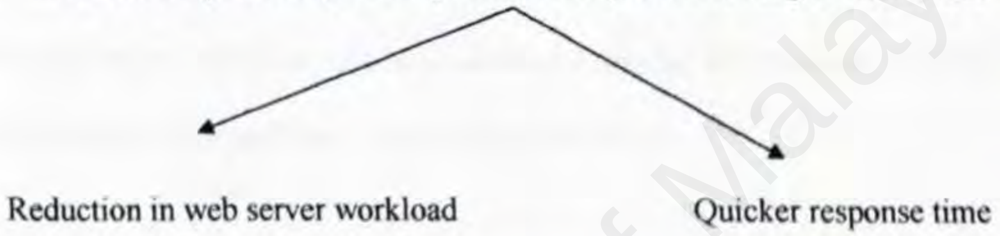


Figure 2.0: The advantages of Client side scripting

Java

The most common and popular form of using Java is using the code to form applets, which are capable of running within the browser environment. It is also a cross platform language in developing applications. Microsoft's Internet Explorer and Netscape's browsers both have built in support for Java.

It offers better functionality compared to scripting languages. File handling and graphics functions are much better laid out together with better security based on the sandbox idea its applets run in. This prevents doubtful programs from doing damage to the environment it's operating in.

JavaScript

This scripting language is synonymous with Netscape. The development of this language is quite interesting. Its original name was to be LiveScript. Due to the popularity of Java, Netscape had collaborated with Sun Microsystems during the development of LiveScript and had borrowed a number of structures from Java's syntax. Thus, its name changed from LiveScript to JavaScript.

It is ideal for validating user input and making sure that data entered by users is valid. JavaScript has the ability to maneuver various browser objects and is intelligently used for bandwidth conservation. It also supports distributed processing by enabling various tasks to be performed on the client rather than on the server. Therefore, this shows that it is less sophisticated and relatively simpler to learn yet powerful enough to be truly useful. Surprisingly, many of the statements are remarkably natural in its terminology and structure.

Many browsers including Netscape Navigator and Internet Explorer supports this script that has a record proven effect on the web engineering arena.

VBScript

One of Microsoft Visual Basic's most popular scripting languages is VBScript, which is compatible with Visual basic for Applications. This language communicates with host applications using ActiveX scripting. The plus point of ActiveX scripting is that other host applications and browsers too do not require special integration code for each scripting component.

Environments like Microsoft Internet Explorer, above version 3.0 and Microsoft Internet Information Explorer version 3.0 allows active VBScript scripting. Thus, its proven that among the main features of this script is its ability in providing automation, customization and scripting capabilities for Web browsers.

The fact that only Internet Explorer supports this scripting language can quite easily be rectified with the aid of a propriety add-in.

2.5.2 Microsoft Visual Interdev 6

This program provides an integrated environment that brings together a number of technologies that would work together in pursuit of one common goal, that is the building of a robust and dynamic application for the web.

Visual Interdev provides a robust and rich set of visual database tools to enhance productivity with an immediate effect. Either the major ODBC compliant databases on the server or the desktop is supported well by this software. This is because database integration is vital to practically any application.

By default, it supports the use of some types of scripts like Jscript and VBScript. Given that the appropriate scripting engine for the language is available, a scripting language like PerlScript can be used for project development. Visual Interdev provides the capability of server side and client side script.

The main object oriented technologies that exist for developing web based applications like ActiveX controls and Java applets are supported by the program. Using script codes that are transformed to scriplets that are object-based functions within a Visual Interdev project is possible. Custom ActiveX controls and the use of third party ActiveX controls are supported too.

Visual Interdev 6 enables a single developer to work and test parts of a project against local web server without having to interfere with the team, then synchronise and deploy changes the shared Master Web Server. Additional web site connections can be done without additional programming. On the other hand, Query Builder permits developers to visually construct complex SQL statements against any ODBC database. Moreover, any query can be tested in the live test pane before being used in the Web page.

2.5.3 Perl

Perl has now become the language of choice across all platforms for programmers engaged in numerous actions like rapid prototyping, system utilities, software tools, database access and World Wide Web programming.

Most written programs are written in Perl. The specialty of this program is that it works on different platforms and systems. Thus, it is also known as the 'glue' language. Therefore, it is popular with system administrators who use it for an infinite number of automation tasks. It has its roots in UNIX, Macintosh, OS/2, Amiga and other operating systems too. Perl programs are highly portable across systems as it is an interpreted language. As there isn't a great deal of overheads, it is possible to complete a task at a blistering speed. Therefore, it lends itself to fast development. Since it is compiled at real-time, there is no need for a compiler and linker. It's a great way to do many small ad-hoc tasks fast.

However, problems are very likely to occur. Run-time compiled code is never as fast, as thin or as scalable as compiled code. The lack of a structured development environment can lead to obscure, non-archived, poorly structured and minimally documented programs.

There is no doubt in the ability of Perl as a programming language. It is a very creative of thinking about anything, which makes it more than just a programming language.

2.6 Relational database

A database quite simply houses information that is connected to a particular application. It can be liken to the ubiquitous filing system in any conventional office. Currently, numerous relational databases are used in various fields and departments. Visual FoxPro, Microsoft SQL Server 7.0 and Microsoft Access 97 just to name a few.

2.6.1 Microsoft SQL Server 7.0

The above-mentioned nonprocedural language supports manipulation, definition, and control of data in relational database management systems. It can only be used for handling databases. Therefore, it's a special purpose language. Applications with a general purpose cannot be written with it. SQL is usually embedded in some other language, which gave it its nickname, a data sub language. It is nonprocedural because it just specifies what has to be done. There is no mention of how it should be achieved. SQL is always only concerned about results and not procedures.

The one very fundamental thing is the fact it provides access to relational databases. One might thing its synonymous but in fact they are not. SQL Server 7.0 has many innovations. Among others:

- A dynamic self-management and row level locking.
- SQL Server desktop.
- A wide array of replication options.
- Scalable in many ways.
- Microsoft Repository.
- Integration with Microsoft Office 2000 and Microsoft Visual Studio. Easy to be integrated with most Microsoft related products.
- Microsoft English Query.

All these innovations make the SQL Server 2000 rather high on scalability and superb in data warehousing. Organizations that run on Office 2000 in particular should take advantage of new ways in which both the above can be integrated to achieve greater heights in data administration.

2.6.2 Oracle

This is a relational database management system and has many functions in many areas, and has proven itself a highly reliable system. Among the advantages offered by the system's architecture are:

- **Connectibility**

It allows computers and operating systems of different types to work under different networks.

- **Database integrity**

Oracle enforces data integrity, the 'rules' that dictate the standards of accepting data.

- **Read consistency**

It is read consistent in the following way:

- Data can be updated without having to take into consideration whether another person is reading it. In this way, it can make sure that writers of the databases' data do not have to wait for readers of the same data.
- It makes sure that readers of the database data do not need to wait for another reader of the same data. That means two or more concurrent reading can happen.
- The set of data seen at a single point of time will change during transaction execution.

- The only wait in data access is that if a write is occuring to a particular row of data e.g. age 40-100, then another data administrator would have to wait for it to be completed before the same row can be updated.

High reliability and controlled availability

At most work sites, Oracle is capable of working 24 hours a day with no down time. The administrator can disallow the use of a particular application in order for it to be reloaded, without having an affect on other applications.

Manageable security

It provides fail-safe security features to limit together with monitoring data access.

Industry standards

Oracle fulfills and surpasses many standards set by various concerned bodies. Among them are:

- For system management, Oracle supports the Simple Network Management Protocol (SNMP) standard. Due to this fact, heterogeneous systems can be managed with a single administrative interface.
- It's 100 % compliant with entry level of ANSI/ISO SQL 92 standard by The U.S. National Institute of Standards and Technology.
- Fulfills U.S. Government's FIPS 127-2 standard.

- Compliant with the Orange Book security criteria after being evaluated by U.S. Government's National Computer security Center (NCSC).

2.6.3 Microsoft Access 97

Microsoft estimated that currently 12 million people use the software that is one of the best selling relational database packages for Windows on the market. In this context, all the data is stored in a compilation of tables, forms, queries, reports and other objects.

One has to remember that Access is a desktop database package. It is not fair to compare it with other much superior programs as the ones explained before this. Those databases have engines that are much more powerful in terms of multi-user capabilities and of course, speed. It would only be fair to compare Access with the ones in its class. Therefore, it does not provide good performance when run across a network and when a number of users would like to utilize it at once.

But, its performance capabilities are quite good if one remembers that it's used as a desktop database with limited multi-user capabilities. It integrates well with other Microsoft packages like Windows as the operating system and Office as the application base. This is the huge advantage it has against other packages because the probability that one is using a Microsoft product is very great. Access is rich in features and data transfer between Access and other Office components is relatively simple.

Its user friendly nature makes it quite a helpful tool in decision making where a particular data search needs to be quick and the result has to be effective. User can add, delete or rearrange fields in the table structure. The properties sheet of a field allows one to control how the data should be entered into a table.

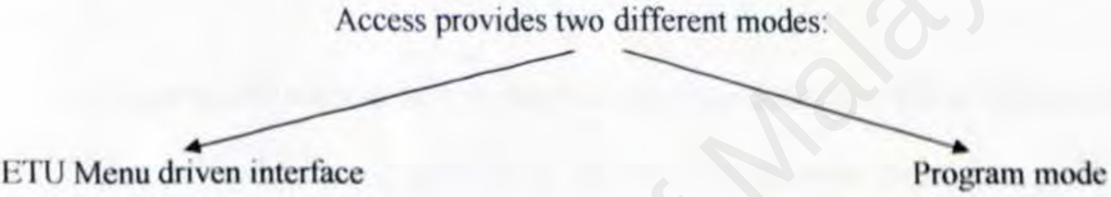

Access provides two different modes:
ETU Menu driven interface
Program mode

Figure 2.1: Two different modes of Microsoft Access

In the ETU (Easy to use) menu driven interface, one is allowed to issue commands. This is done without the in depth understanding of Access.

However, the program mode lets users store instructions in a Visual Basic program file and thereafter execute all of them with one command.

2.7 Web Servers

2.7.1 Microsoft Personal Web Server (PWS)

Microsoft's Personal Web Server is the scaled down version of Internet Information Server (IIS), which is included with the server edition of Microsoft Windows NT. This great web server simplifies the process of publishing, serve personal web sites and to share documents via a local Intranet. It has features that stresses on the clients' ease of use.

To get up and running quickly, the best way is to administer PWS. Users can use the familiar Internet Explorer interface to browse around, share directories, view web site statistics together with the ability to start and stop servers. Wizards are present to guide users with the setting up web sites process and sharing files.

The user is allowed to check out validity applications, scripts, links and ensures the proper functionality of the site's overall organization. Therefore, it serves as a platform for testing out web sites before hosting them on the Internet. Once the site is ready and complete, the user can either continue using the PWS or utilize the Microsoft Front Page to transfer the web site to IIS (Internet Information Server). Although Microsoft front page is bought separately, the IIS and PWS come together in a pack as part of the freely downloadable Windows NT 4.0 Option Pack.

There are some differences between the IIS and PWS though. As stated earlier, PWS is the scaled down version of the IIS. Thus, it would definitely lack in some aspects like tools, capabilities and features. It does lack the advanced features found on IIS like the Index Server, Microsoft Site Server Express Tools and Certificate Server.

On the contrary, it does support ASP coding, script debugging and the Internet Service Manager, which is a comprehensive tool used in IIS as part of the Microsoft Management Console. Moreover, its ability in developing transactional Web applications using the Microsoft Transaction Server is also presented. Usually the difference of usage between the IIS and PWS will be divided according to the usage and complexity required. The distinction in the choice is shown below:

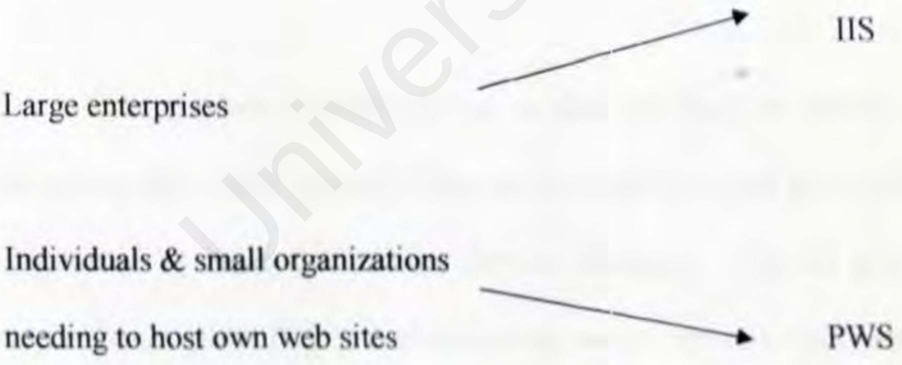

IIS
Large enterprises
Individuals & small organizations
needing to host own web sites
PWS

Figure 2.3: Distinction of choice between IIS and PWS

2.7.2 Internet Information Server (IIS)

IIS is the largest of the two web servers available from Microsoft and it is the only World Wide Web server that is tightly integrated with the Microsoft Windows NT / 2000 operating system. It provides the ability to provide services, not only for web pages, but also for FTP sites i.e. the ability to transfer whole files from one site to another, NNTP services, which are newsgroup services together with audio and video services.

IIS includes security features and promises that it is easy to install. It works relatively close with Microsoft Transaction Server in order to be able to access databases and in providing control at the transaction level. Microsoft's Netshow which delivers audio and video streaming, delays and lives works together with it too.

The security features are up to date and easy to install. In addition to the Windows NT / 2000 security features, one can set Read only or Execute only virtual directories by using the Internet Service Manager. The IIS also supports Transport Layer Security and Digest Authentication, which are two examples of the new security protocols. The security helps in protecting the computer and its resources by requiring user accounts and passwords. The administrator can control access to computer resources by limiting the user rights to these accounts.

IIS also provides a way in which a particular IP address can be barred from having access to the system it's governing. Moreover, it supports the Secure Sockets Layer (SSL) protocol too. This efficiently secures data transmission between servers and clients.

One of the most important areas of focus of IIS is in its ability to provide powerful access control functionality for Web access to files for applications on the server. This includes a built in search engine, rich logfile, analysis tools and for dynamic motion capabilities, its streaming multimedia capabilities.

However, IIS needs to be run on a large machine. It lacks collaborative computing components, messaging and object store.

The question regarding the usage of a single server to run the IIS or multiple servers to do the job needs much research. This is because of the availability of 5 different modules which need to be integrated. The choices are as below :

Option 1:

Availability of 5 different servers that house 1 module each. Thus, should one server be down, only one module would be temporarily unavailable. The rest would be available.

Option 2:

All the modules operate from one server itself. This would prove to be more cost effective and less of a configuration problem.

2.7.3 Netscape Enterprise Server

This web server supports Oracle, Java, and Informix and is also capable in converting .pdf files to HTML files. It has a direct link to a DBMS and automatic directory tree. The Netscape Enterprise server can run either in an UNIX environment or in a Windows based environment.

This commercial web server is one of the most expensive one in the market to date. It provides multiple database connections, persistent transactions and stored procedures. It uses the standard NCSA log format, has built in image maps (NCSA) and is compatible with the CGI interface.

2.7.4 Apache 1.3

This UNIX based web server is available without any cost. Hosting multiple IP addresses on an Apache server is easily executed with little configuration. This software can be obtained on the Internet together with the complete module and core source code.

This can then be modified to suit the applicable situation according to the developers needs.

It is one of the fastest servers available but must be set up and maintained by editing the configuration files. Apache allows for authentication based on user ID and password and can prohibit access from specific domain names and IP addresses. It offers multiple methods from which customization of error messages and the capability to customize other key needs e.g. text responses and local and external URL redirection. However, an allowance for the usage of graphical user interface is not available.

2.8 Security Management

Stringent safety regulations should be applied to a system that is of the Integrated Smart Health Care Systems nature. This is because data that is posted and kept within the precincts of this system are very sensitive and personal, especially regarding payment information and disease information together with the diagnosis reports.

The security could be divided to three features:

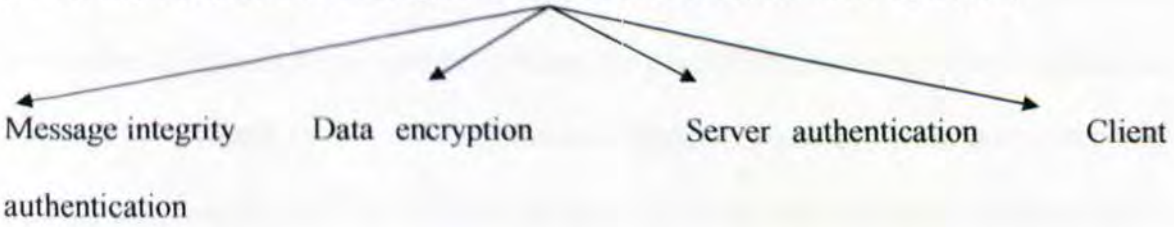
- Integrity of the system must be guaranteed.
- Authorized users must be able to perform whatever they are required to do.
- The system must always be available at users wish albeit dependent at the level of use.

Hence, the complete security strategy would include deterrence, protection, response measures and detection. An example of a step towards this direction would be to hide the URL (Uniform Resource Location). This would mean that all subsequent pages after the main page where the log in is required would have the identical URL as the main page where the log in took place.

The Internet is an abundant supply of information that is very dynamic in nature and constantly evolving. Evolution means that data is sent across the line so that the required changes can take effect. The data (message) that is transmitted over the line can be intercepted at any time by people who have an intention and a motive in doing so. Therefore, efforts should be directed at securing the message itself. Secure Socket Layer (SSL) provides just that particular kind of protection.

2.8.1 Secure Socket Layer (SSL)

SSL was designed by Netscape as a non-proprietary protocol. It was built upon private key encryption technology. For any TCP/IP connection, SSL provides:



Message integrity Data encryption Server authentication Client authentication

Figure 2.4: Among the provision given by SSL

It uses the TCP/IP on behalf of the higher-level protocols, and in the process allows an SSL enabled server to authenticate itself to an SSL enabled client, allows the client to authenticate itself to the server, and allows both machines to establish an encrypted connection.

- SSL client authentication

This allows the server to confirm a user's identity. Using the same techniques used for server authentication, SSL enabled sever software can check that a client's certificate and public ID are valid and have been issued by a certificate authority (CA) listed in the server's list of trusted CA's. This confirmation is important particularly if the server that' sending information happens to be a bank's, which is sending confidential financial information to a customer and wants to check the recipient's identity.

- SSL server authentication

Here, a user gets to confirm a server's identity. SSL enabled client software can use standard techniques of public key cryptography to check that a server's certificate and public ID are valid and have been issued by a certificate authority (CA) listed in the client's list of trusted CA's. This confirmation might be important if the user, is sending a credit card number over the network and wants to check the receiving server's identity, as an example.

- Encrypted SSL connection refers to the fact that all information that is sent between across a client and a server should be encrypted by the sending software and decrypted by the receiving software, thus providing a high degree of confidentiality. Confidentiality is important for both parties in any private transaction. Moreover, all data that is sent over an encrypted SSL connection is protected by a mechanism for damage tampering. This means that it would be able to automatically determine if the data has been altered by nature in transit.

2.8.2 Digital certificates

Also dubbed as an electronic credit card, a digital certificate can establish ones credentials when doing business or other transactions over the World Wide Web. The CA, which issues the digital certificate, is a trusted third party that does it to subscribers; by biding their identities to the key pairs they use to digitally sign electronic communications.

Expiration dates, a serial number, the name of the subscriber, a copy of the certificate holder's public key and the digital signature of the certificate are among the features contained in a digital certificate. The certificate holder's public key is used for encrypting and decrypting messages and digital signatures whereas the digital signature of the certificate is the issuing authority in order for the recipient to be able in verifying the validity of the certificate.

There is a standard to which most of the digital certificates conform to, the X.509. Examples of CA's are Thawte and the more popular VeriSign. X.509 is the most widely used standard for digital certificates, and is used to implement SSL security in both, Internet Explorer and Netscape Navigator.

3.0 Methodology

3.1 Development models

Many models exist in today's development arena. For example, the RAD Model, Spiral Model, Incremental Development Model, DOD Model, Rapid Throwaway Prototype Model, Waterfall Model and Prototyping are a few of the many models available for guidance during developing a particular system or item.

For the development of this system, the strategy that will be administered will be not one, but a combination of two models, which are the *Waterfall Model* that will be complemented with *Prototyping*. This is so that the strength of both the models can be tapped in a combination that will be useful in accurate and timesaving development.

Prototyping will be done in the earlier stages of the development where uncertainties run high in user requirements areas in particular. The prototype will help in examining and decision-making regarding the compatibility and appropriateness of a particular module or sub section for the finished product. Key requirements are developed to test the consistency, practicality and feasibility. In short, prototyping is useful for validation and verification.

The waterfall model is useful in presenting a high level view of what goes on during system development together with the sequence of events that are likely to be encountered. Using this model, reviews of each phase of development can be accomplished. It allows specifications to be altered should unforeseen discrepancies occur as development starts and progresses. The advantages that were offered by this model are:

- A well documented process.
- Standardization occurs.
- The process can be tailored to meet the specific yet possibly changing needs of any application.
- Document content and review criteria are well defined.

There are some disadvantages though:

- The formal involvement of operators and users is not present.
- It is figured to be incompatible with Expert Systems (ES).
- It might just prove to be expensive.
- The paradigm fails to recognise the iterative and concurrent nature of the process.

Most of the above-mentioned disadvantages can be counter acted upon using of the prototype. Being web based, the only possible thing to be shared by each module of the Smart Health Care Information system would be the database. Because the database is the core component of the complete system, extra care needs to be taken to design a well thought out database which will be efficient in handling of requests from all the modules attached and integrated.

Below is the graphical model of the interaction between the two proposed development models.

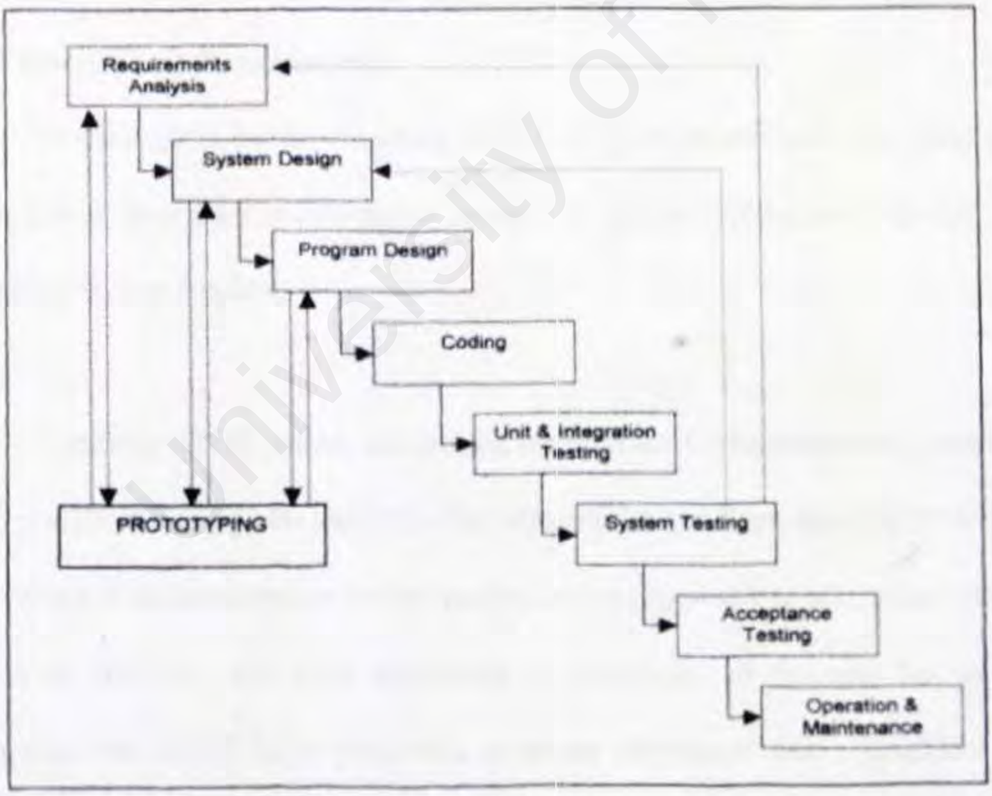


Figure 3.0: The Waterfall Model with Prototyping

3.2 Software development tools

3.2.1 Microsoft Visual InterDev 6.0 (VI)

VI comes as part of the Visual Studio, Microsoft's suite for programming tools. It has a graphical environment that allows users to create ASP's. A whole range of HTML tags and an attribute together with a full set of tools and the allowance of using Jscript or VBScript comes along with VI.

It also boasts strong links with SQL Server, which would ease the setting up of databases with a combination of ASP and SQL Server.

3.2.2 Macromedia Dreamweaver

Dreamweaver handles building HTML 3.2 components well, like most graphical tools, but it also does substantially more. It supports Netscape plug-ins, ActiveX controls and Java Applets.

Dynamic HTML effects are created for both the 4.0 browsers and permit the user to do it without coding. Its just like what Microsoft Front Page does for HTML coding. It's created in an environment where coding is not required but effects are there. Also known as DHTML, this code generation is automatic, all the user has to do is to manipulate the CSS-P layer properties to create animation with a graphical timeline, something rather similar to Macromedia Director.

3.2.3 Evrsoft 1st Page 2000

Evrsoft automatically build navigation bars that include specified groups of pages. It gives ultimate in power, flexibility and ease in creating and managing the particular web site.

At the menu itself, one has the choice of beginning in various environments. Namely easy, expert, hardcore or normal. It begins in a start up page in which the user can do a number of things before documenting the actual document. For example, the teach me HTML icon, references for SSI, CSS, Java Script and other common questions at the click of another icon and for the seasoned user, he might just jump straightaway at *start creating web pages.*

It is very versatile and has a load of scripts ready to be used, which includes VBScripts, Java Scripts and DHTML codes. Thus, the user needs just moderate expertise in the usage of ActiveX, Java applets and Java Scripts.

***Note - During proposal**: This program will be tried out first to see its effectiveness in an environment based on Windows. Should it not perform as expected, the Microsoft Front Page 2000 will be utilised instead.*

***Note – During implementation**: Both the above mentioned programs were not used, instead the Macromedia Dreamweaver was used as it generates much lesser code. This was seen during the development process itself.*

3.2.4 Active Server Page

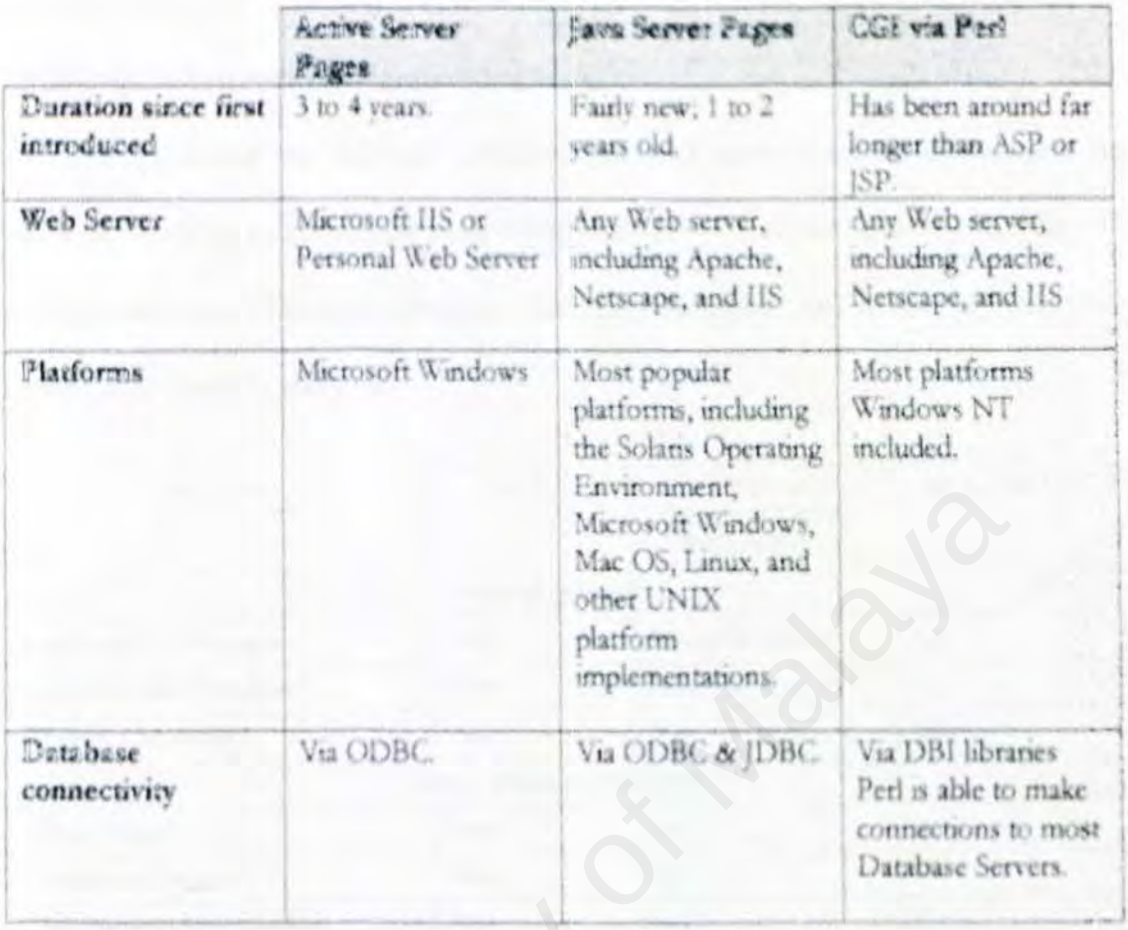
ASP is chosen because it creates dynamic data. It contains a set of instructions that are processed by IIS on the web server. The ASP code returns the results of the server side processing by dynamically generating a HTML document.

The ability to generate HTML on the fly, programmatic access to ActiveX components and the combination of scripting languages undoubtedly make ASP a powerful yet versatile tool for dynamic web page building.

3.2.5 VBScript

It is the default language of ASP. It is implemented fast and as a portable interpreter for use in web browsers with applications that use Java applets, ActiveX controls and OLE Automation servers.

One of the most conspicuous upper hand that VBScript has is that its ability in bringing active scripting to a wide choice of environments. This would include Web client scripting in Microsoft Internet Explorer V 3.0 and Web server scripting in Microsoft Internet information Server V 3.0. This proves its compatibility with the system that would integrate later.



	Active Server Pages	Java Server Pages	CGI via Perl
Duration since first introduced	3 to 4 years.	Fairly new; 1 to 2 years old.	Has been around far longer than ASP or JSP.
Web Server	Microsoft IIS or Personal Web Server	Any Web server, including Apache, Netscape, and IIS	Any Web server, including Apache, Netscape, and IIS
Platforms	Microsoft Windows	Most popular platforms, including the Solaris Operating Environment, Microsoft Windows, Mac OS, Linux, and other UNIX platform implementations.	Most platforms Windows NT included.
Database connectivity	Via ODBC.	Via ODBC & JDBC.	Via DBI libraries Perl is able to make connections to most Database Servers.

Table 3.0: A comparison between ASP, JSP and CGI via Perl

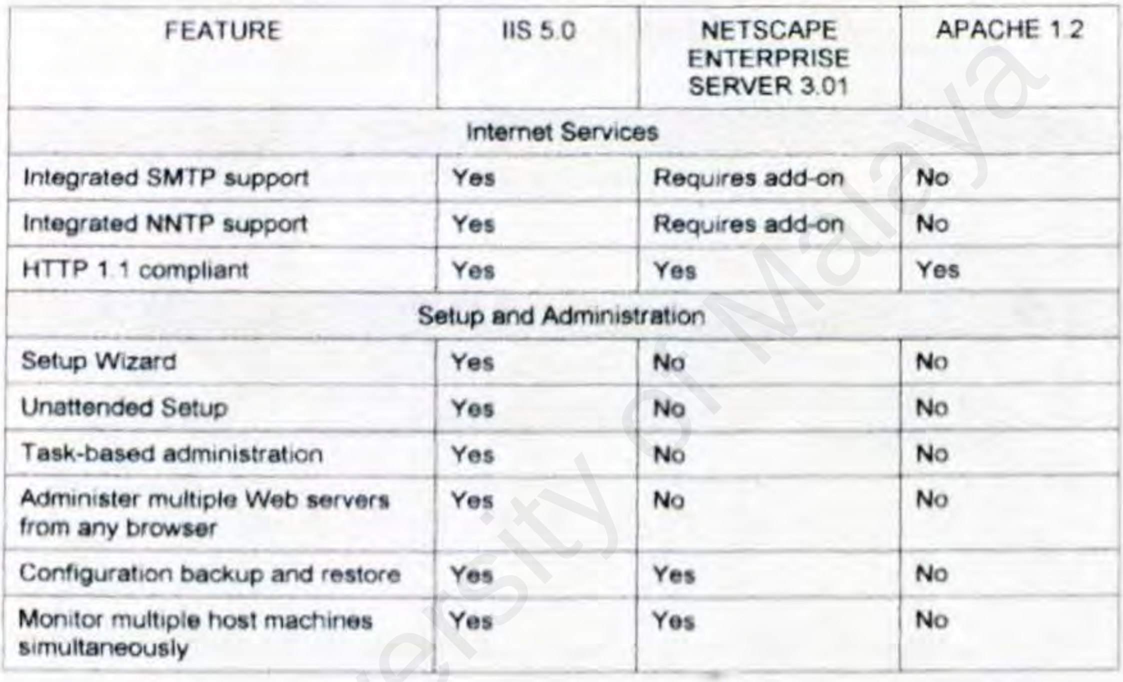
3.2.6 Summary

Visual Interdev was chosen as the ASP editing tools. Integrated web server, single object store, well balanced adoption of ActiveX and Java and a programmable architecture makes it a good choice for web developers. The other programs would be used to provide miniature templates of a particular interactive graphic. Microsoft Visual Basic 6.0 will be used to create GUI's as it's very popular as a prototyping tool and is relatively easy to learn.

3.3 Server choice

3.3.1 Microsoft Internet Information Server (IIS)

The guarantee the network administrator and application developer gets on security, networking and administration functionality by IIS is just what is required. IIS integrates well with Microsoft Windows Directory Services. IIS is also familiar with Windows functionality and tools.



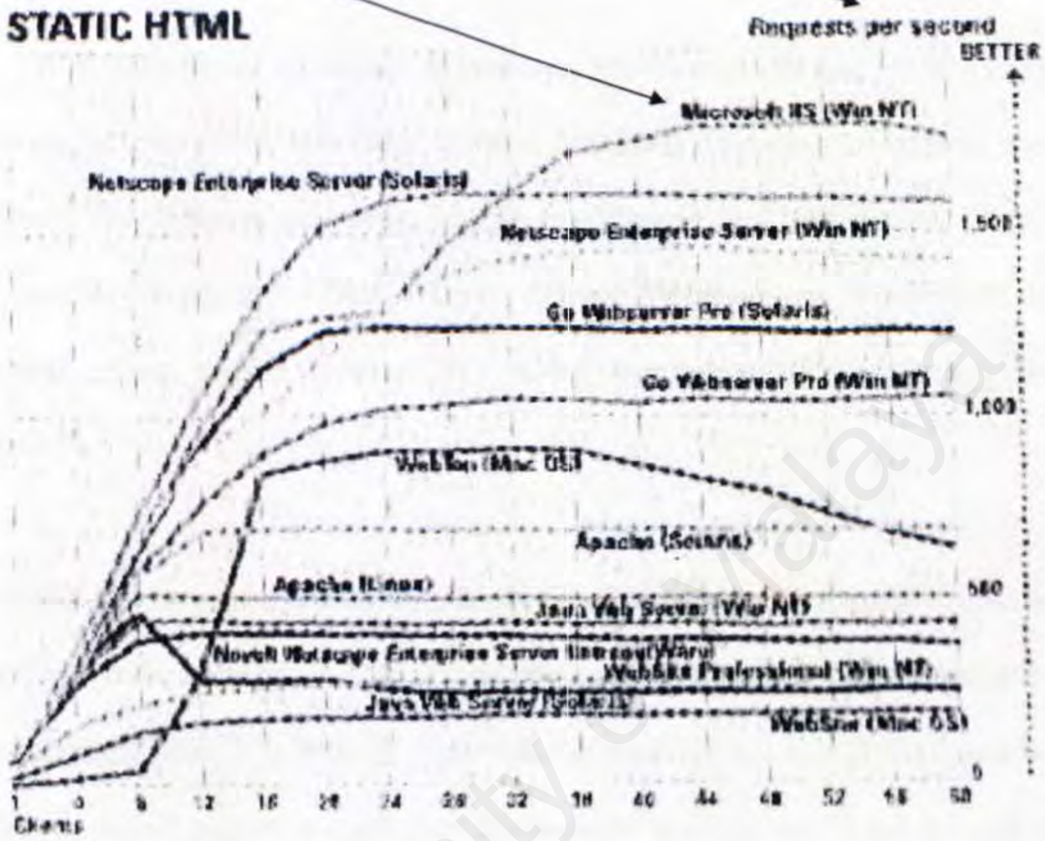
FEATURE	IIS 5.0	NETSCAPE ENTERPRISE SERVER 3.01	APACHE 1.2
Internet Services			
Integrated SMTP support	Yes	Requires add-on	No
Integrated NNTP support	Yes	Requires add-on	No
HTTP 1.1 compliant	Yes	Yes	Yes
Setup and Administration			
Setup Wizard	Yes	No	No
Unattended Setup	Yes	No	No
Task-based administration	Yes	No	No
Administer multiple Web servers from any browser	Yes	No	No
Configuration backup and restore	Yes	Yes	No
Monitor multiple host machines simultaneously	Yes	Yes	No

Table 3.1: A comparison of servers and their capabilities

IIS has built-in capabilities to help administer secure Web sites and to develop and deploy server-intensive Web applications like the IntSHIS. Its integration with other Microsoft tools such as Microsoft Message Queue, Visual Interdev and Microsoft Transaction Server is very well accepted. Since this system will be using Microsoft related products that complements each other, it only strengthens the notion of having the IIS as the web server.

Microsoft IIS

Requests per second



Clients

Figure 3.1: A Comparison of leading servers by performance

3.4 Database Management Systems

3.4.1 Microsoft SQL Server 7.0

With SQL Server for Microsoft Windows 95, Windows 98 and NT Workstation, the developer can count on a fully featured relational database management system (RDBMS) that performs well across mobile applications and workstations. A single code base for all platforms, from a laptop running the ubiquitous Windows 95 to an integrated system running Windows NT server, it provides 100 percent application compatibility.

SQL Server is also able to store terabytes of data and support up to 50 concurrent users to use at the same time. This is something, which Microsoft Access will never be able to cope up with. It is because Microsoft Access limits the size of the database. In addition, it cannot support a multi user environment well. Access is not suitable for a system that is a big one like the IntSHIS. It does not provide good performance when run across a network and when many users converge at once.

3.5 Operating System

3.5.1 Windows 2000

Microsoft advertises crash protection for Windows 2000 that will keep applications from running even if the other applications go down. A number of features are available that make Windows 2000 the best platform available to publish information and share it securely over the corporate Intranets and Internets.

Among them are:

- Support for multiple web sites on a single machine.
- Innovative web publishing features.
- Customizable tools and new wizard technologies for simplification in execution of commands.
- A big improvement over Windows NT 4.0, with improved security, performance, reliability and better user interface. Also, better administrative facilities.
- More integrated functionalities with the allowance for less bugs in the system.

	Windows 2000 Server	Windows 98	Linux
Security	Secure log in procedures and support for web security. e.g. SSL.	Not secure.	Secure due to log in facilities.
User interface	GUI.	GUI.	Strong command line plus GUI via Windows Managers.
Scripting languages	ASP, JSP, Perl, VBScript, JavaScript & AWK.	JSP, Perl, PerlScript, VBScript & JavaScript.	JSP, Perl, JavaScript, PerlScript & AWK.
Stability	Stable.	Not so stable.	Very stable.
Web server ready	Internet Information Server, Netscape Enterprise server.	Personal Web Server & Apache.	Apache.
Database	SQL Server, Oracle, MySQL.	MSAccess & MySQL.	PostgresSQL &MySQL.
Load handling	Not robust enough for high traffic.	Unable to handle high traffic.	Able to handle high traffic on server.
Pricing	Pretty steep.	Expensive.	Available free via download.

Table 3.2: A comparison of the different operating systems that were considered

3.6 Web browser

3.6.1 Internet Explorer 5.0

Good interaction between JScript and VBScript with Internet Explorer was one of the reasons this browser was chosen. Both VBScript and Jscript are essentially plug in scripting languages i.e. that they interact with Internet Explorer's underlying ActiveX scripting architecture to drive the Web browser.

A comparison of the browsers is shown below:

Features	Netscape Navigator 3.0	Microsoft Internet Explorer3.0
Multimedia	It has the same capabilities as IE but separate plug ins are required.	AVI movies, AIFF and AU sound formats and MPEG video formats are supported.
Platform support	Supports Windows, Macintosh, and Unix variants such as Solaris and AIX.	Available only on specific platforms like UNIX, Windows and Macintosh.
Java & Scripting support	Runs java smoothly but doesn't widely support other Scripts such as VBScript.	IE is 15 % faster than Navigator for compute-intensive applets is. It runs Java better and broader scripting support helps Web developers as well.
Security	The same level of security as IE is provided, apart from the support for parental control and rating systems.	Supports SSL and site certificates. Supports parental controls and rating systems too.
Speed	Navigator 3.0 is about 35% faster then IE 3.0	Slower marginally then the Navigator.
Mails & news	A wizard is present that walks through the process of setting the mails, online identity and new servers. Basic rules and filtering for incoming message is provided.	Mails and news clients are present in every version but basic rules for filtering messages are not provided.

Table 3.4: A comparison of the main browsers

3.7 Run Time Requirement

3.7.1 Server – side Hardware Requirement

The following computer configuration was found to be the most suitable, cost – effective and optimal environment.

Internet Information Server (IIS) and Ms SQL Server 7.0 on the server computer

- 266 MHz or better Pentium – compatible Central Processing Unit (CPU).
- 256 MB of RAM recommended; 128 MB minimum supported; 4 GB maximum capable.
- 2.0 GB hard disk with a minimum of 1.0 GB unallocated space. It should be noted that additional space would be required if installation is going to occur over a network.
- Network Interface Card boasting a bandwidth of at least 10Mbps and higher.
- Other standard peripherals.

3.7.2 Workstation Hardware Requirement

The same machine i.e. the server should not be used as the development platform. Instead, a different machine that would operate as a workstation is strongly advised and recommended.

This basically ensures that the testing and coding phases will not affect the performance of the servers as they are required to run at optimal performance.

Windows 2000 Professional or Windows 98 Machine

The development work would require Microsoft Windows 2000 Professional. As many would argue, the Windows 98 platform will do also. However, after much research, it was substantially agreed that it is not as stable as the Windows 2000 Professional platform.

- 166 MHz or better Pentium compatible CPU.
- Windows 98 with 64 MB RAM recommended minimum; but more memory on the whole improves responsiveness.
- 2 GB hard disk with a minimum of 650 MB of unallocated space.
- Windows 2000 Professional is capable of supporting single or dual CPU systems.
- Network Interface Card with a bandwidth of at least 10 Mbps or more.
- Together with other standard computer peripherals.

3.7.3 Client – side Hardware Requirement

Undoubtedly, this area's requirements are quite negligible. Any types of computers equipped with reasonably fine peripherals should be able to browse through the Net with not much difficulty. Furthermore, it should be interconnected and attached to a modem with acceptable speed. Sufficient RAM would improve responsiveness.

Any operating system be it UNIX, Linux (the freeware version of UNIX) or Windows, the site should be able to be surfed as long as there is a web browser pre - installed. But, a web browser with JavaScript functionalities is definitely preferred.

4.0 System Design

4.1Overall design of the Integrated Smart Health Care Information System

As my research stresses on the integration of the 5 existing modules, an overall view of how the modules would interact with each other was conceived albeit at a *very primitive* stage equivalent to the requirement of a proposal.

Note: This has been further explained now as the whole system is complete.

This is illustrated in a graphical manner for proper understanding of the overall system. Currently, the sixth module, that is The System for Analyzing Medical Data is still being developed. Thus, it hasn't been included in this Level 0 Data Flow Diagram (DFD).

The main entry point into this system is via the main page. At the main page, the user can access a number of general functions that would be available to everyone without having to become a registered user. In this case, the registered user are able to access more functions by logging into the system by utilizing a specified user name and password which will be determined by the system administrator.

The User Definition table is the only shared data source at this level of the system design. It contains the user names and definitions for every user in the system dependant on their level of entry. Each module in this system accesses this table to verify users before they are allowed entry into any particular module of their choice.

- Data Flow Diagrams (DFD)

The graphical characterization of the data processes and flows in a system is shown using a technique called DFD. The DFD gives an overview of the system outputs and inputs and the flow of data through each process.

To be able to understand the signs in DFD's that will follow, the basic symbols are depicted below:

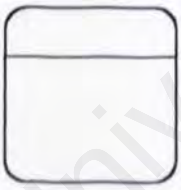
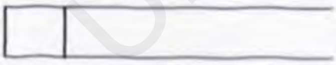
SYMBOL	**DEFINITION**
	Transformations of data
	Data in static storage
→	Flow of data

Table 4.0 : Data Flow Diagram symbols

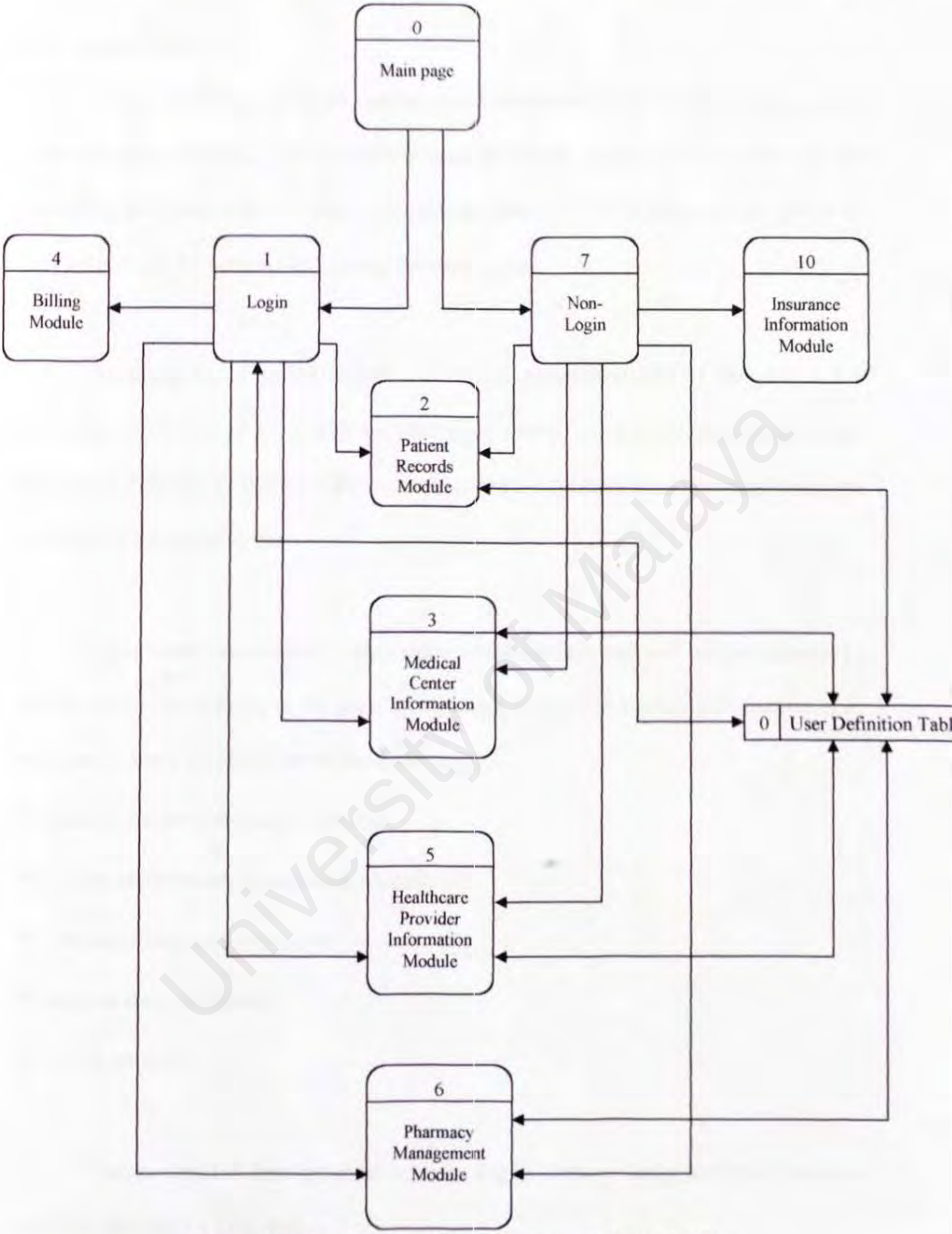

0
Main page
4
Billing Module
1
Login
7
Non-Login
10
Insurance Information Module
2
Patient Records Module
3
Medical Center Information Module
0
User Definition Tabl
5
Healthcare Provider Information Module
6
Pharmacy Management Module

Figure 4.0: Level 0 Data Flow Diagram of the IntSHIS

4.1.1 Login Users

Access privileges for each module are determined in the User Definition table from the user groupings. By controlling user privileges, access to the system can be controlled by system administrators. Accidental crashes of the system and corruption of data sources can be avoided by limiting the user access.

By doing so, it would enable the system administrator(s) of the site to the determine the source of any problem (what went wrong) should any user access cause the system to crash. In this way, the cause of errors can be determined without having to run through the entire system.

Login users have access to other value added services that will not be available to regular users. By logging in the users will be able to view or modify information in at least one or more of the following modules:

- Medical Center Information Module
- Healthcare Provider Information Module
- Pharmacy Information Module
- Patients Records Module
- Billing Module

A more detailed description of how the log in portion works with the system is shown in the Level 1 DFD below:

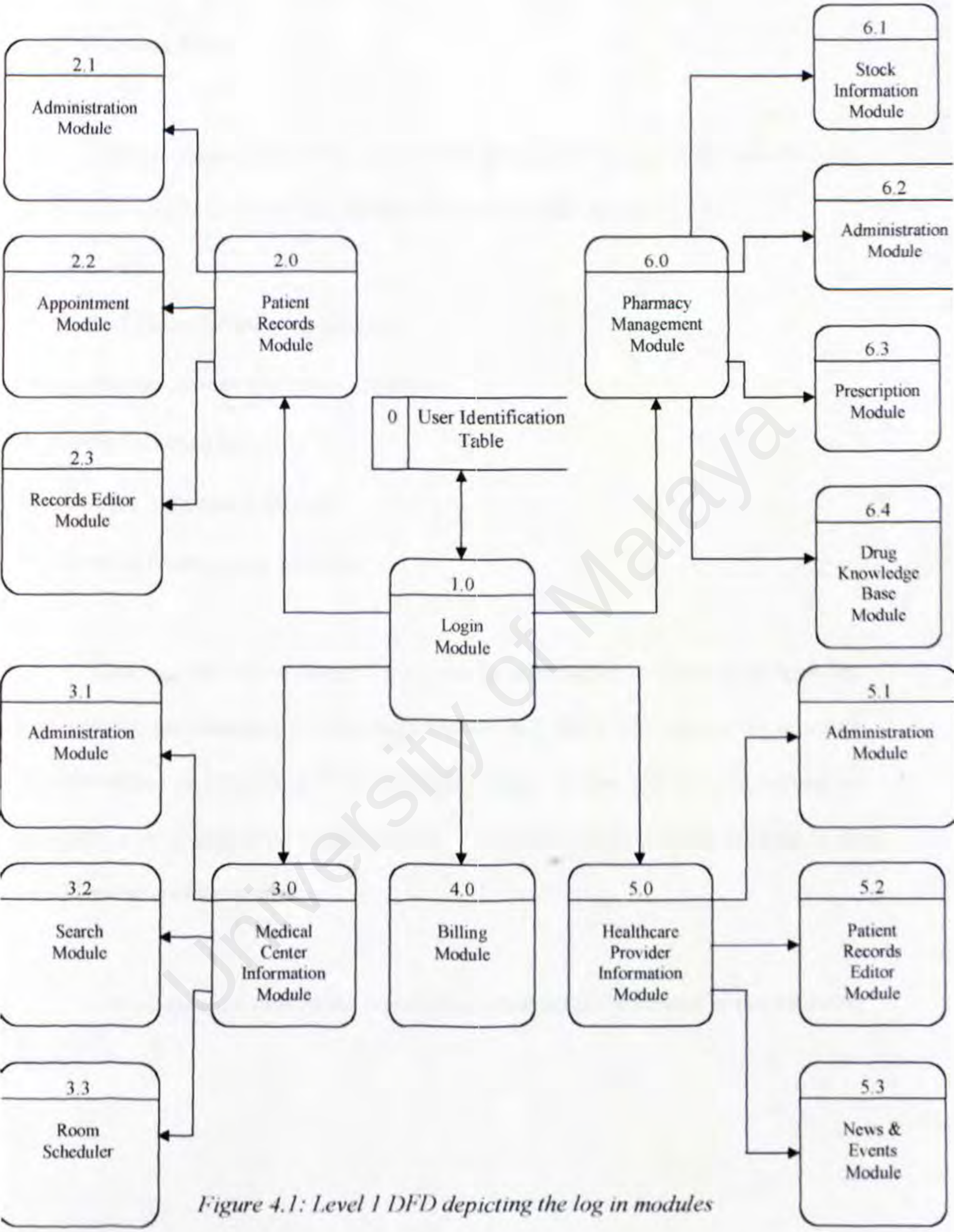


Figure 4.1: Level 1 DFD depicting the log in modules

4.1.2 Non-login Users

The non-login portion of the system will have access to four of the main modules used by the system as well as one additional module, which are as follows:

- Medical Center Information Module
- Healthcare Provider Information Module
- Patient Records Module
- Insurance Information Module
- Pharmacy Management Module

Users will be able to search the system for information in some of the modules. For example, the Pharmacy Management Module will allow non-login users to search for information on drugs in its Drug Knowledge Base. In this way, user interaction for non-login users is kept to the bare minimum. This would aid in avoiding mishaps in the overall working of the system.

A more detailed view of the Non-login portion could be viewed in the following figure.

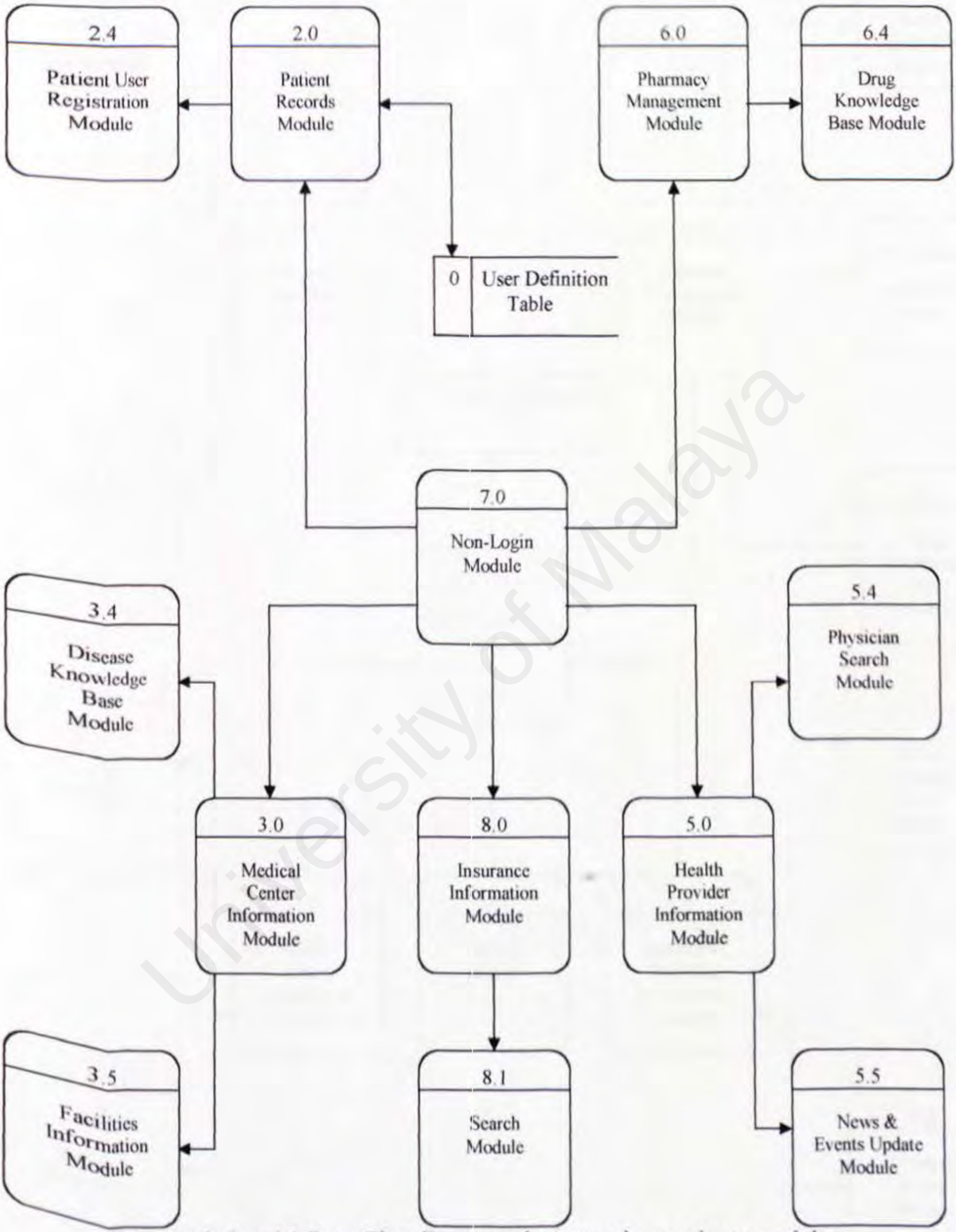

2.4
Patient User Registration Module
2.0
Patient Records Module
6.0
Pharmacy Management Module
6.4
Drug Knowledge Base Module
0
User Definition Table
7.0
Non-Login Module
3.4
Disease Knowledge Base Module
5.4
Physician Search Module
3.0
Medical Center Information Module
8.0
Insurance Information Module
5.0
Health Provider Information Module
3.5
Facilities Information Module
8.1
Search Module
5.5
News & Events Update Module

Figure 4.2: Level 1 Data Flow Diagram depicting the non-login modules

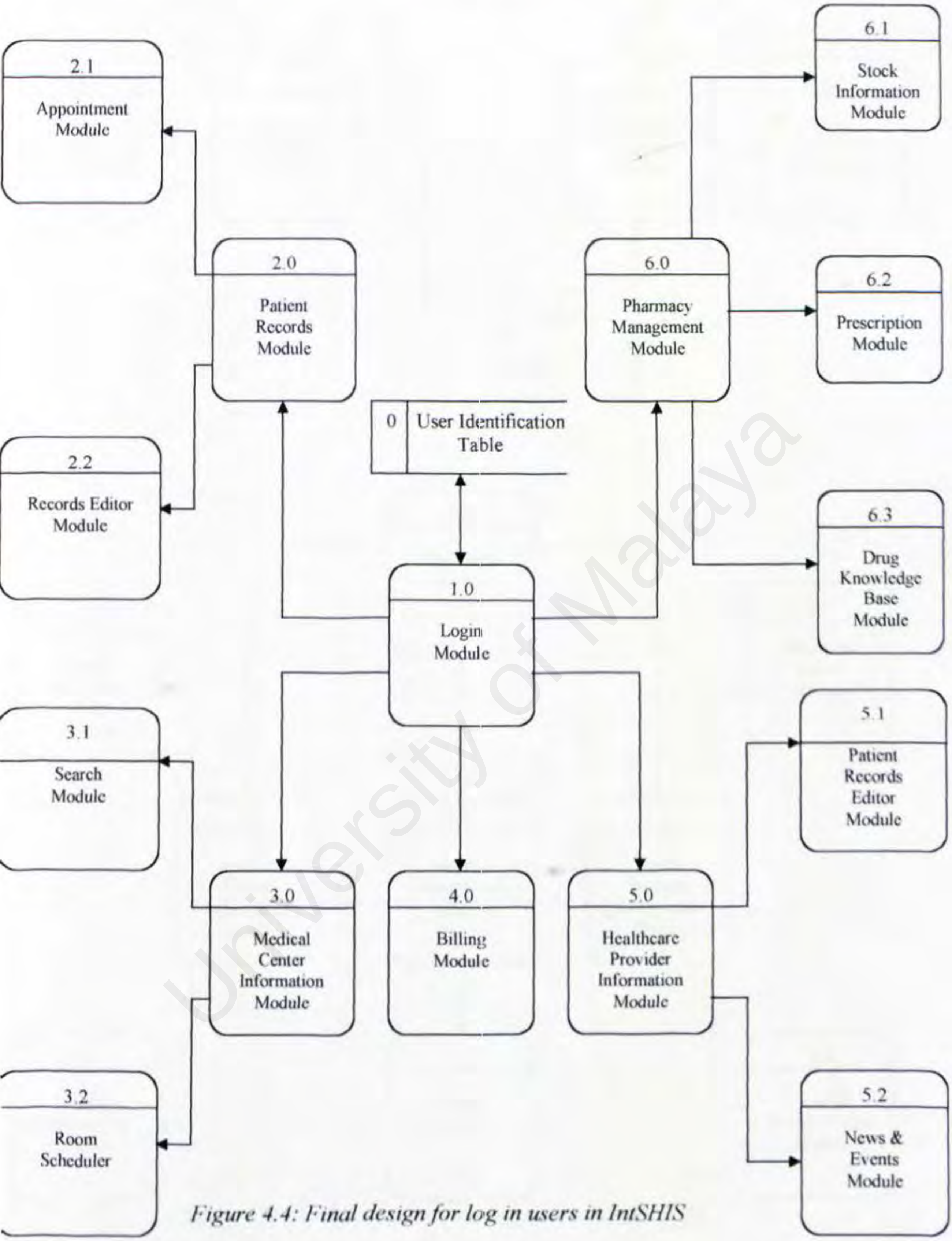


Figure 4.4: Final design for log in users in IntSHIS

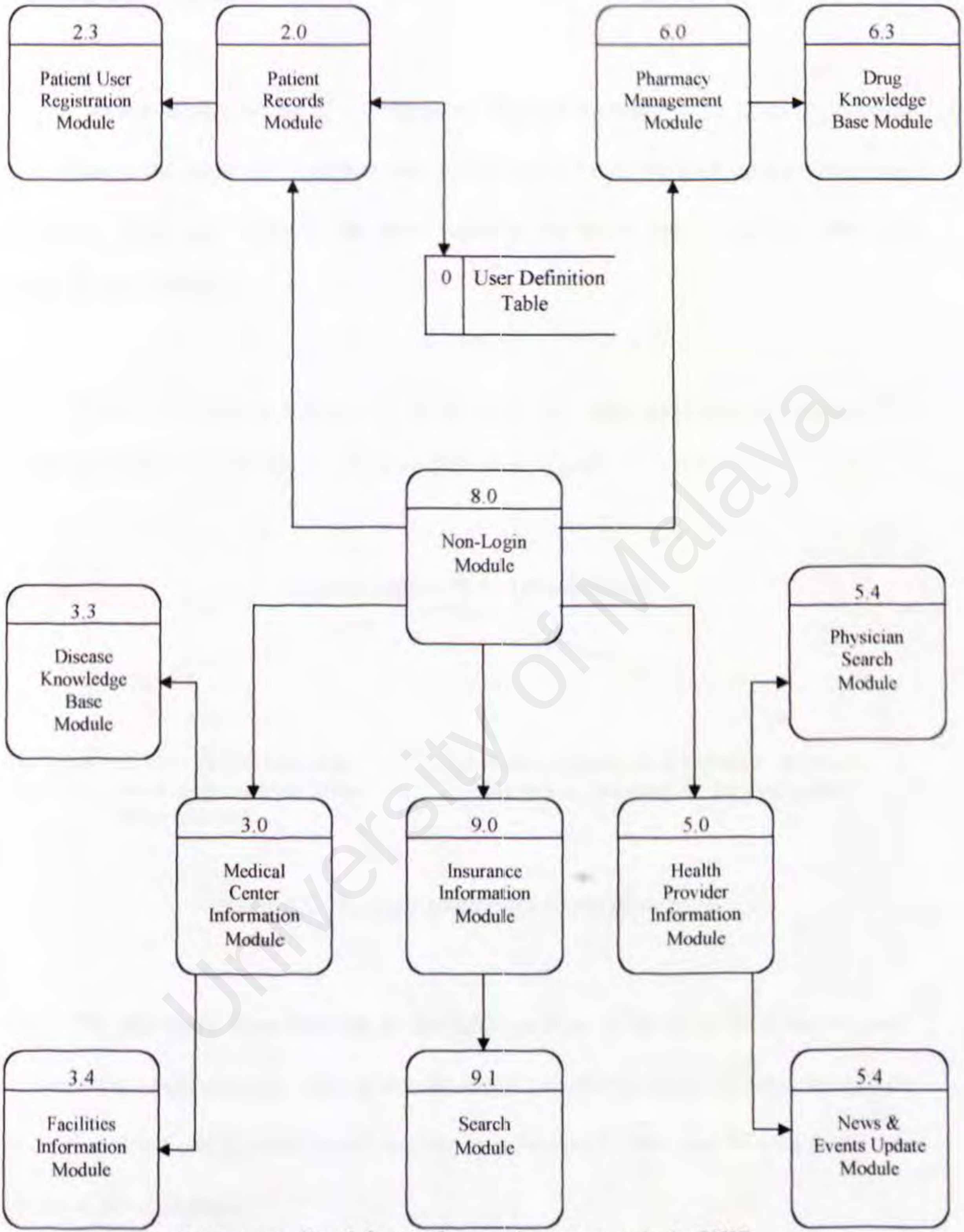
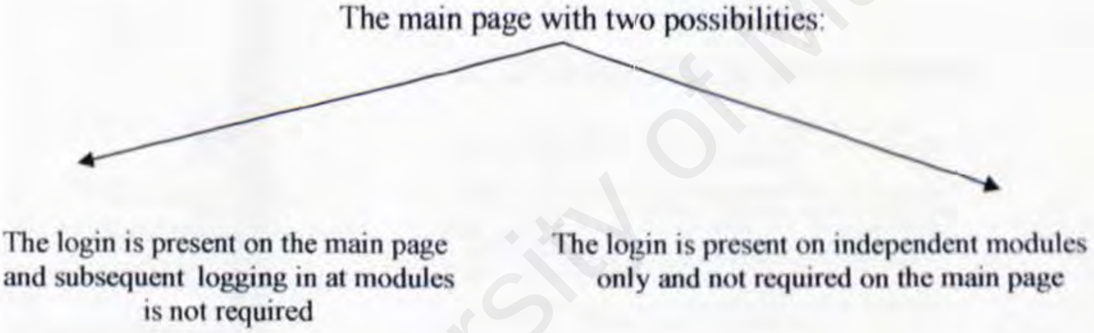

2.3
Patient User Registration Module
2.0
Patient Records Module
6.0
Pharmacy Management Module
6.3
Drug Knowledge Base Module
0
User Definition Table
8.0
Non-Login Module
3.3
Disease Knowledge Base Module
5.4
Physician Search Module
3.0
Medical Center Information Module
9.0
Insurance Information Module
5.0
Health Provider Information Module
3.4
Facilities Information Module
9.1
Search Module
5.4
News & Events Update Module

Figure 4.4: Final design for non log in users in IntSHIS

4.2 Sample screen shot

As the project would be developed in the next semester, a bit of an experiment was done on the main user interface that would interact with the user to reach the other modules. This page would be the entry point to the health center's website that will house all the modules.

The section on the bottom left corner about the login and password requirement is still debatable. This is explained in the following figure.



The main page with two possibilities:

The login is present on the main page and subsequent logging in at modules is not required

The login is present on independent modules only and not required on the main page

Figure 4.5: The login possibility on the main page

Note: ***The first login type (the one on the left)*** *has been accepted to be in use to create a hassle free environment. User of any level can access the required data through the main page itself and no subsequent logging in is required. This can be seen in the new layout at the next page.*

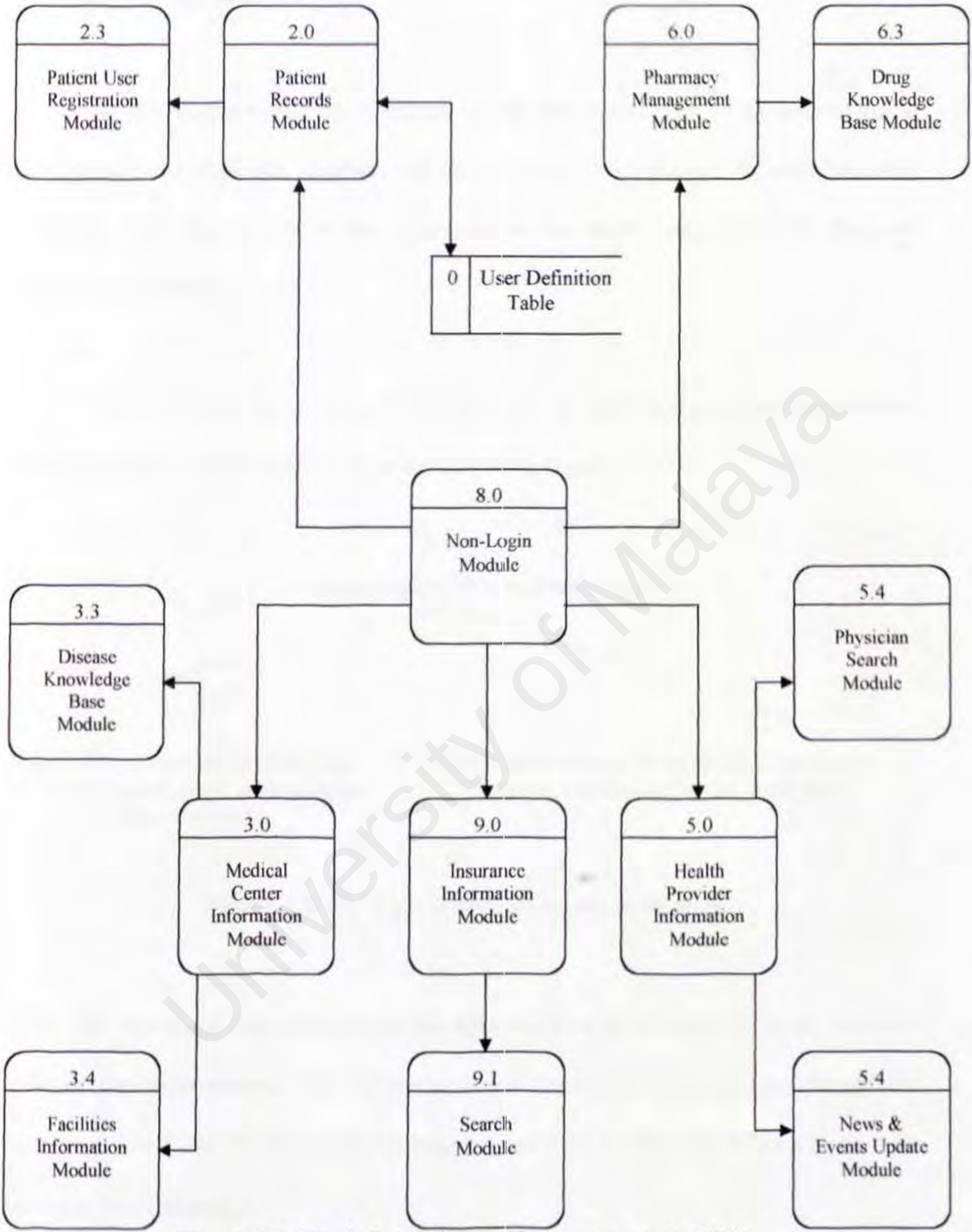
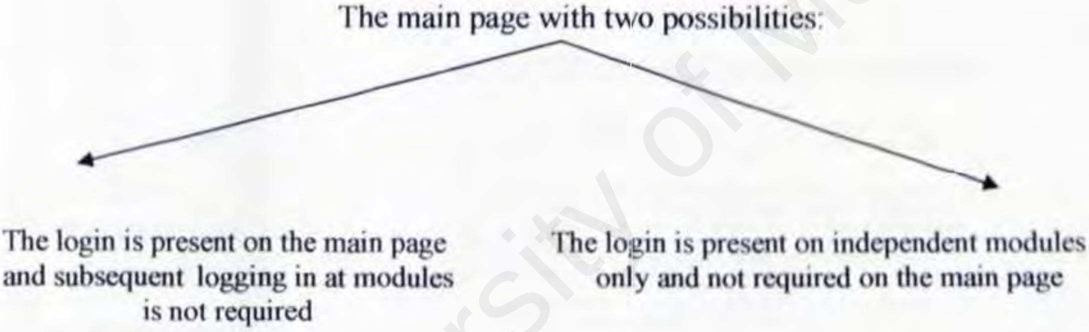

2.3
Patient User Registration Module
2.0
Patient Records Module
6.0
Pharmacy Management Module
6.3
Drug Knowledge Base Module
0
User Definition Table
8.0
Non-Login Module
3.3
Disease Knowledge Base Module
5.4
Physician Search Module
3.0
Medical Center Information Module
9.0
Insurance Information Module
5.0
Health Provider Information Module
3.4
Facilities Information Module
9.1
Search Module
5.4
News & Events Update Module

Figure 4.4: Final design for non log in users in IntSHIS

4.2 Sample screen shot

As the project would be developed in the next semester, a bit of an experiment was done on the main user interface that would interact with the user to reach the other modules. This page would be the entry point to the health center's website that will house all the modules.

The section on the bottom left corner about the login and password requirement is still debatable. This is explained in the following figure.



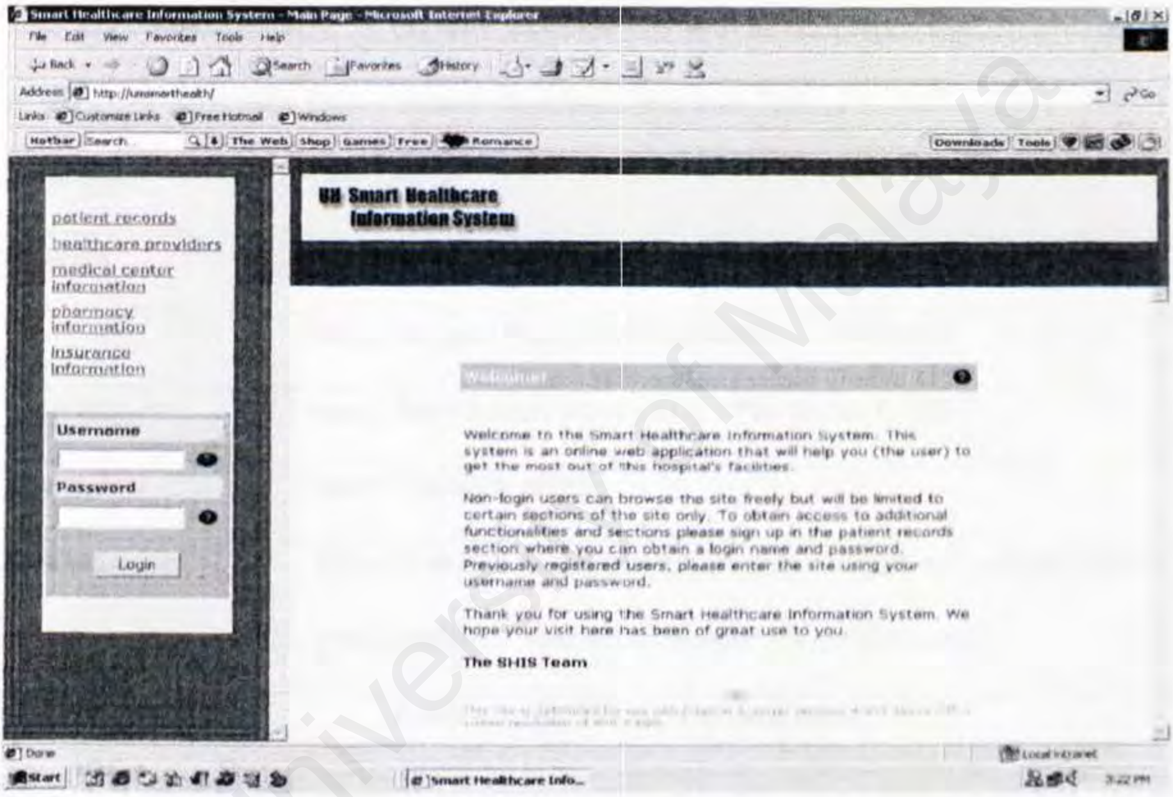
The main page with two possibilities:

The login is present on the main page and subsequent logging in at modules is not required

The login is present on independent modules only and not required on the main page

Figure 4.5: The login possibility on the main page

Note: ***The first login type (the one on the left)*** *has been accepted to be in use to create a hassle free environment. User of any level can access the required data through the main page itself and no subsequent logging in is required. This can be seen in the new layout at the next page.*



Smart Healthcare Information System - Main Page - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Address http://umsmarthealth/
Go
Links Customize Links Free Hotmail Windows
Hotbar Search The Web Shop Games Free Romance Downloads Tools
UM Smart Healthcare Information System
patient records
healthcare providers
medical center information
pharmacy information
insurance information
Username
Password
Login
Welcome!
Done
Local intranet
Start
Smart Healthcare Info...

Welcome to the Smart Healthcare Information System. This system is an online web application that will help you (the user) to get the most out of this hospital's facilities.

Non-login users can browse the site freely but will be limited to certain sections of the site only. To obtain access to additional functionalities and sections please sign up in the patient records section where you can obtain a login name and password. Previously registered users, please enter the site using your username and password.

Thank you for using the Smart Healthcare Information System. We hope your visit here has been of great use to you.

The SHIS Team

[illegible]

Figure 4.6: Main page layout screen shot

4.3 Database design of the various modules.

4.3.1 Health Insurance Information and Billing Module Overview

Data dictionary

This is a specialised application of the kinds of dictionaries used as references for system analysis to guide them through the design and analysis phases. In this project, it is quite vital to be aware of some of the data dictionary as well as data types used in Microsoft SQL Server database. This is clearly illustrated below in Table 4.1.

Data type	Description
smallint	stores integers from -32768 to 32767
int	stores integers from -2147483648 to 2147483648
smalldatetime	stores dates ranges from Jan 1, 1900 to Jun 6, 2079
char	stores character strings
varchar	Variable length of character type data. Values are without spaces is non unicode. Maximum length is 8000 characters

Table 4.1: Description of data types

Both of the above mentioned modules share these 2 tables:

a) Group_Definition

b) Insurance_Company

User_Definition

This would decide on whether a user will be granted access in the database. *The User Definition table is the main shared data source among every single module in the Smart Healthcare Information System (SHIS). It determines the user access for every part of the system. Thus, making it important that this table be made as secure as possible.*

Field name	Data type	Length	Description
User_Id	int	4	The ID of the user in the database.
User_Name	Char	15	The user's login name.
Password	Char	8	The user's login password.
User_Code	Int	4	The code used to refer to the user's category.

Group_Definition

The Group_Definition table is used to determine the validity of the authority of entrée in the module. The Group Definition table contains two fields that describe the user groups of the entire system. The other fields denote the access privileges accorded to a particular user group with "Y" signifying access privilege to each section.

The Group_Definition field contains the complete text description of the user groups in the system. The remaining fields basically denote access privileges in the system. A user group who has access to Patient Records portion will have a "Y" filled in the Patient_Records field.

Filed name	Data type	Length	Description
User_Code	int	4	The category in which the user falls into is checked.
Group_Definition	varchar	100	Description of the category.
Patient_Records	char	1	The patient records category flag.
Medical_Center_Info	char	1	The medical center information category flag.
Healthcare_Provider	char	1	The healthcare provider category flag.
Pharmacy_Info	char	1	The pharmaceutical information category flag.
Insurance	char	1	The health insurance information category flag.
Billing	char	1	The billing module flag for cashiers.

All of the user groups contained in this system (SHIS) can be seen in the following table.

Group code	User group
0	System Administrators
1	Patient
2	Nurses
3	Lab Technicians
4	Medical Center System Administrators
5	Physicians
6	Healthcare provider Information System Administrators
7	Pharmacists
8	Pharmacy Stock Information Administrators
9	Insurance Information System Administrators
10	Billing Information Sysstem Administrators
11	Cashiers

4.3.1 (a) Database design (Health Insurance Information sub module)

Data Dictionary

This module deals with one table only as follows:

a) Insurance_Company

Insurance_Company

All the details of the insurance companies are stored here:

Field name	Data type	Length	Description
Company_name	varchar	50	Company's name.
Address	varchar	50	Company's address.
Company_email	varchar	50	Company's email.
Company_url	varchar	50	Company's website url.
Tel_no	varchar	15	Company's telephone no.
Fax_no	varchar	15	Company's fax no.
Company_desc	varchar	200	Brief description of the company.
Row_count	Int	4	Acts as a buffer slot to quicken access. It will determine the total number of rows.

4.3.1 (b) Database design (Billing sub module)

Data Dictionary

The billing module interacts with other tables from other modules too apart from just using the existing tables itself. They are as follows:

a) Billing
b) Billing_misc_item
c) Billing_physician
d) Billing_treatment
e) Billing_medication
f) Adt
g) Patient
h) Misc_item
i) Misc_item_code
j) PhysicianBio
k) Treatment
l) Treat_code
m) Medication
n) Stock_definition

The main billing table contains the primary billing data, together with being the table that links all the other billing tables together.

Field name	Data type	Length	Description
Bill_ no	int	4	To identify each bill with the number.
Patient_id	int	4	The ID number of the patient who is being billed.
Bill_date	datetime	8	The date the bill was issued.
Bill_total	decimal	9	The total amount of the bill.
Admission_date	datetime	8	The admission date, together with Bill_date, is used to determine the the period the bill covers.
Bill_balance	decimal	9	The amount still is owed by the patient.
Current_bill_no	int	4	The last bill created number.

Billing_misc_item

All the basic and miscellaneous items charged to the patient is stored in this table. The old price of the items is also stored in here so that the original amount charged is preserved.

Field name	Data type	Length	Description
Bill_no	int	4	The bill this item is associated with.
Bill_misc_date	datetime	8	The date this item was charged.
Misc_item_id	int	4	Item's ID number.
Unit_price	decimal	9	Item's price, stored in the table.
Quantity	int	4	The quantity of the item's charged.

Billing_physician

The details of the physician who treats the patient is stored.

Field name	Data type	Length	Description
Bill_no	int	4	The bill this physician is associated with.
Phy_id	int	4	Physician's ID number.
Phy_charge	decimal	9	The price of the physician per day.
Phy_no_of_treatement	int	4	The total number of days the physician treated the patient.

Billing_treatment

This table records the treatments which are charged to the patient.

Field name	Data type	Length	Description
Bill_no	int	4	The bill the treatment is charged to.
Bill_treatment_date	datetime	8	The date this treatment was administered.
Treat_rec_id	int	4	The treatment's ID number.
Unit_price	decimal	9	The price of the treatment.

Billing_medication

All the medication charged to the patient are recorded in this table.

Field name	Data type	Length	Description
Bill_no	int	4	The bill this medication is charged to.
Bill_medication_date	Dateline	8	The date this medication was prescribed.
Stock_id	varchar	20	The medication's unique ID.
Price_factor	decimal	9	Medication's price per unit.
Quantity	int	4	The quantity of the medication was administered.

ADT

The ADT table basically houses information about the patient's admission. Retrieving of the patient's physician particulars and admission date for billing purposes is done through this table.

Field name	Data type	Length	Description
Adt_Id	int	4	ADT identifier that is unique.
Patient_ID	int	4	The patient ID.
Date_admission	datetime	8	The patient's admission date.
Physician_ID	int	4	The physician attending this patient.
Ward	varchar	10	The ward the patient is directed to.
Remarks	varchar	10	Miscellaneous remarks.

Patient

All the patient data is contained here. Data like patient names and address can be retrived from here.

Field name	Data type	Length	Description
Patient_name	varchar	50	Patient's name.
Photo_name	varchar	255	For identification purposes.
Patient_ID	int	4	The patient's unique identifier.
Passport	char	8	Passport number of the patient.

Gender	varchar	6	The gender of the patient.
IC_no	char	14	The patient's IC number.
Birthdate	smalldatetime	4	The patient's date of birth.
Race	varchar	15	The patient's race.
Religion	char	15	The patient's religion.
BloodGroup	varchar	2	The patient's blood group.
Marital_status	smallint	2	The patient's marital status.
Nationality	varchar	20	The patient's nationality.
Home_phone	varchar	10	The patient's home phone number.
Mobile_phone	char	10	The patient's hand phone number.
Address	varchar	25	The patient's home address.
Address1	varchar	25	The patient's home address (variant).
Postcode	char	5	The patient's addresses' postcode.
City	varchar	20	The patient's city.
State	varchar	20	The patient's state.
Country	smallint	2	The patient's country code.
Facsimile	varchar	10	The patient's facsimile number.
Email	varchar	30	The patient's email address.
Occupation	smallint	2	The patient's code.

Misc_item

The basic and miscellaneous necessities which were given to the patient are recorded here in this table.

Field name	Data type	Length	Description
Misc_item_id	int	4	The item's unique identifier.
Patient_id	int	4	The patient this item is charged to.
Date_administered	datetime	8	The date this item was charged.
Quantity	int	4	The quantity of the items charged.
Remarks	varchar	50	Misc. remarks.

Misc_item_code

The item's price and description is stored here in this table.

Field name	Data type	Length	Description
Misc_item_id	int	4	The item's unique ID.
Misc_item_desc	varchar	50	The item's description.
Misc_item_price	decimal	9	The price of the item.

PhysicianBio

This table basically consists of data about the physicians who work in the particular medical center. It is used to retrieve the physician's charges for billing purposes.

Field name	Data type	Length	Description
Phy_id	int	4	The physician's unique ID.
Last_name	varchar	20	The physician's last name.
First_name	varchar	25	The physician's first name.
Speciality	varchar	20	The physician's specialty.
Contact_no	varchar	11	The physician's contact number.
Phy_charge	smallmoney	4	The fee.
Education	varchar	50	The education level of the physician.
Email_1	varchar	30	The primary email of the physician.
Email_2	varchar	30	The secondary email of the physician.
Phy_pic	varchar	25	
Last_update	smalldatetime	4	The date data was last updated.
Modified_by	int	4	The date data was last modified.

Treatment

Treatment records of patients are stored here in this table.

Field name	Data type	Length	Description
Treat_rec_id	int	4	The unique ID of the treatment.
Patient_id	int	4	The patient to which the treatment was administered.
Treatment_id	varchar	100	The ID of the treatment itself.
Date_treated	smlldatetime	4	Date of the treatment.
Attend_PhyID	int	4	The physician who gave the treatment.
Remarks	varchar	100	Misc. remarks.

Treat_code

The treatment's description and price is stored here in this table.

Field name	Data type	Length	Description
Treatment_Id	int	4	The unique ID of the treatment.
Treatment_desc	varchar	50	The treatment's description.
Treatment_price	decimal	9	The price of the treatment.

Medication

The medication records of patients are stored here.

Field name	Data type	Length	Description
Patient_id	int	4	The patient to whom the medication was administered.
Stock_id	varchar	20	The unique ID of the medication.
Date_prescribed	datetime	8	The date the medication was prescribed.
Quantity	int	4	The amount of medication prescribed.
Attend_PhyID	int	4	The physician prescribing the medication.

Stock_definition

It has all the data on medicine. It is used to retrieve the name of the medication and prices for billing purposes.

Field name	Data type	Length	Description
Stock_Id	varchar	20	The unique Id of the medicine.
Name_generic	varchar	50	The generic name of the medicine.
Name_trade	varchar	50	The trade name of the medicine.
Recoder_level	decimal	9	The reorder level of the medicine.
Quantity_stock	decimal	9	The balance in the stock.
Quantity_per_unit	Float	4	The amount per unit available .
Quantity_total	Int	4	The total amount of medicine.

Dosage_per_unit	int	4	The medication's dosage.
Unit_code	varchar	10	The measurement used for the medication.
Price	decimal	9	The price per unit of medicine.
Expiry_Date	datetime		

4.3.2 Pharmacy Management System Overview

Once one normalization was done, the Stock Definition table was divided into further 2 separate tables. The 2 tables are as below:

- Stock Definition table. (itself)
- The Stock Unit table.(Added)

This was done so that any occurrence of loss of unit measures will be minimized. This could particularly happen should the details of any particular drug be omitted from the system.

The fields that are contained in the Stock Definition table could be referred to page 79.

Stock_Unit

Field name	Data type	Length	Description
Unit_Code	Varchar	10	As below.
Unit_Description	Varchar	20	As below.

The Unit field is replaced by the Unit_Code field. This field contains information that identifies the unit of measure that is used for a particular drug. It contains a specific code. On the other hand, the Unit Description field houses the full text description of a unit of measure which is used in relation to the corresponding unit code. It should be highlighted that the data in this table correlates to the Dosage Per_Unit field.

Drug_Knowledge_Base

Field name	Data type	Length	Description
Name_Trade	varchar	50	As below.
Name_Generic	varchar	50	As below.
Drug_Description_File	varchar	50	Filled with name of text file that contains the description of a drug. Other details about the drug also.

The reason why the Name_Trade and Name_Generic fields are replicated in the above table is due to the fact that the administrator might want to include information on medication that may not be available in the medical center.

These above mentioned tables are the only ones that are applicable to the Pharmacy Management System. The rest of the tables already exist in the other modules which make them shared tables. They are listed below:

1. Medication
2. Stock_definition
3. User_definiton
4. Group_definition

4.3.3 Patient Information System Overview

Similar to the other modules, there are some shared tables and some independent ones. The independent tables will be explained first. They are as follows:

Patient Problem (Disease) History

This table stores information on any diseases that may have affected the patient and the time of its contact in particular.

Field name	Data type	Size	Description
ID	int	4	For the record created a unique number is done.
Patient_ID	int	4	The ID of the patient.
Disease	varchar	100	The disease that has infected the patient.
Symptom	varchar	100	The disease's symptoms.
Attend_PhyID	int	4	The physician's ID who had attended to the patient.
Date_encountered	smalldatetime	4	Date or time the patient was infected by the disease.

Patient's Vital Signs

This table stores information on the vital signs upon admission or examination.

Field name	Data type	Size	Description
VS_ID	int	4	For the record created a unique number is done.
Patient_ID	int	4	The patient's ID.
Date_measured	smalldatetime	4	Date when the vital signs were examined.
Systolic	int	6	Blood pressure. (contraction)
Diastolic	int	6	Blood pressure.
Pulse	smallint	1	Pulse count of the patient.
Temperature	smallint	2	Patient's body temperature.
Height	smallint	2	Patient's height.
Weight	smallint	2	Patient's weight.

Patient's Lab Tests

This table would house the information on the results of any sort of test that would have occurred.

Field name	Data type	Size	Description
LT_ID	int	4	For the record created a unique number is done.
Patient_ID	int	4	Patient's ID.
Test_ID	varchar	30	The nature of the test.
Test Result	varchar	100	The test's result.
Date_test	smalldatetime	4	Date of the test.

Patient's Drug Allergy

Information on allergy that a patient may be inflicted with is stored here.

Field name	Data type	Size	Description
Patient_ID	int	4	Patient's ID
Date_observed	smalldatetime	10	Date when the allergies were noticed.
Allergy	varchar	30	The drug allergy's name.
Severity	varchar	10	The severity of the drug allergy.
Reaction	varchar	20	Reaction to the drug allergy.

Appointment

The appointment table in which the input on details of the appointment agreed upon is stored.

Field name	Data type	Size	Description
Patient_ID	int	4	Patient's ID.
Speciality_ID	int	4	The doctor's area of expertise.
Date_Appointed	smalldatetime	2	Date the appointment was made.
Time_ID	smallint	2	Time slot of the appointment.

There are a number of shared tables too that make up the entire database (tables) for the Patient Information System module. They are as follows:

1. Patient
2. User_Definition
3. Treatment
4. ADT
5. Medications

4.3.4 Medical Center Information System Overview

The MCIS's database (MCIS.dsn) consists of 12 tables and only 2 are shared tables. Namely, the User_definition and Group_definition. The rest are as follows:

CenterInfo

This table consists of the data pertaining a medical center that belongs to a particular medical group.

Field name	Data type	Length	Description
Center_ID	int	4	The medical center's ID number.
Name	char	50	Medical center's name.
Address	varchar	50	Postal address.
City	varchar	50	City its situated in.
State_ID	int	4	State ID number.
ZipCode	varchar	5	Postal zipcode.
Tel	varchar	11	Telephone number.
Fax	varchar	11	Fax number.
WebAdd	varchar	50	Web site's URL.
Email	varchar	50	Email address.
Speciality	varchar	200	Specializes particularly in which field.

Facility

Some other information about the medical center is kept here. For example, number of beds, staff, services etc.

Field name	Data type	Length	Description
Fac_ID	int	4	The facility's ID.
Fac_Title	varchar	100	Facility's name.
Fac_Tel	varchar	11	Telephone number at the particular place.
Fac_Desc	varchar	500	Description of what it can offer.

Job

The job opportunity available in the medical center is listed down here. The positions available, qualifications, due date, description, contact person etc. can be keyed in by the administration for the user to view and applying.

Field name	Data type	Length	Description
Job_ID	int	4	The job ID number.
Job_Title	varchar	50	The name of the job.
Job_Desc	varchar	500	Job's description.
Job-Req	varchar	500	Job's requirement.
Person	varchar	50	Contact person.

Address	varchar	50	Postal address.
City	varchar	50	City.
State_ID	int	4	State ID number.
Zip	varchar	5	Zipcode.
Tel	varchar	11	Telephone.
Fax	varchar	11	Fax number.
Email	varchar	50	Email address.
CloseDate	datetime	8	Closing date.

Tender

The tenders that are available in a medical center are stored here. The tender title, qualification, due date and certain particulars on the contact person can be keyed in by the administration section and could be viewed and applied by the user.

Field name	Data type	Length	Description
Tender_ID	int	4	The tender's ID number
Tender_refno	varchar	20	Tender's reference number.
Tender_Title	varchar	200	The tender's name.
Tender_Desc	varchar	500	Tender's description.
Tender_Req	varchar	500	Tender's requirement.

Tender_Fee	money	8	Tender's fees.
Person	varchar	50	Contact person.
Address	varchar	50	Postal address.
City	varchar	50	City.
State_id	int	4	State ID number.
Zip	varchar	5	Zip code.
Tel	varchar	11	Telephone number of the section in charge.
Fax	varchar	11	Fax number.
Close_date	datetime	8	Closing date.
Close_time	datetime	8	Closing time.

Disease

Specific diseases' information is stored in here together with the description of them.

Field name	Data type	Length	Description
D_ID	int	4	Disease's ID number.
D_Name	varchar	50	Disease's name.
D_Desc	varchar	1000	The description of the disease.
D_Cause	varchar	1000	The causes of the disease.
D_Symptoms	varchar	1000	Symptoms of the disease.
D_Treatment	varchar	1000	Treatment for the disease.

Lab_test

The information on lab tests and their prices' are stored here.

Field name	Data type	Length	Description
Test_ID	varchar	5	Test ID number.
Test_name	varchar	50	Test name.
Test_price	money	8	Description and prices.

Prefix

The prefixes for the treatment and lab tests' codes are stored in here.

Field name	Data type	Length	Description
Prefix	Char	1	From A to Z.

SMNO

The treatment code and lab test code are stored here. The table will be updated every time the treatment code and the lab test code increases.

Field name	Data type	Length	Description
Prefix	char	1	Prefixes from A to Z.
Prefix_Desc	varchar	20	Description of the prefixes.
LastNo	Char	4	Last number.

State

The state ID and their description is stored here.

Field name	Data type	Length	Description
State_ID	Int	4	The state's ID.
State_Desc	Varchar	40	Description of the state.

Treatment

The table stores the information on the treatment and its prices.

Field name	Data type	Length	Description
Treatment_ID	char	5	Treatment ID number.
Treatment_Name	varchar	50	Treatment's name.
Treatment_Price	money	8	A brief description of the treatment.

4.3.5 Health Care Provider Information System Overview

Similar to the other modules, there are some shared tables and some independent ones. The independent tables will be explained first. They are as follows:

Health Care Consultation Schedule

The table below keeps the information on the health care provider's schedule.

Field name	Data type	Length	Description
Phy_ID	int	4	Stores the healthcare provider's unique ID number.
Day	varchar	3	Stores the consultation day.
StartTime1	varchar	7	Stores the consultation start time.
EndTime1	varchar	7	Stores the consultation end time.
StartTime2	varchar	7	Stores the consultation start time.
EndTime2	varchar	7	Stores the consultation end time.
Last_Update	smalldatetime	4	Stores the healthcare provider's record's last update time and date.
Modify_By	varchar	15	The creator/modifier's username is stored here.

Specialty

This table houses the list of specialties available in the hospital, which is used in conjunction with the health care provider's information table.

Field name	Data type	Length	Description
Specialty_ID	int	4	Stores the number of specialties available in the table.
Specialty	varchar	50	Stores the names of the available specialties.

News and Events

All the events that are happening in the medical center are explained here.

Field name	Data type	Length	Description
Event_ID	int	4	Store the event's type.
Event_Date	varchar	10	Store the event's date.
Event_Time	varchar	8	Store the event's time.
Location	varchar	60	Store the event's location.
Host_Name	varchar	50	Store the event's host name.
Event_Title	varchar	60	Store the event's title.
Event_Description	varchar	160	Store the event's description.
Fees	smalldatetime	4	Store the event's fee charges.

Contact_No	varchar	11	Store the event committee's telephone number.
Fax_No	varchar	11	Store the event committee's fax number.
Email_Add	varchar	30	Store the event committee's email address.
Last_Update	smalldatetime	4	Store the event record last update time and date.
Modify_By	varchar	15	The creator/modifier's username is stored here.

Newsletter Mailing List

This table keeps the email addresses of the SHIS newsletter subscribers.

Field name	Data type	Length	Description
No	int	4	The unique number that is SQL generated for email addresses added.
Email_Add	varchar	30	Store the subscribers' email addresses.
Date_Created	smalldatetime	4	Store the date and time the new email addresses were added.

There are a number of shared tables too that make up the entire database (tables) for the Health Care Information System module. They are as follows:

1. Health Care Provider Info
2. Problem History
3. Drug Allergy
4. Group Code
5. User_Definition
6. Group_Definition
7. Medication

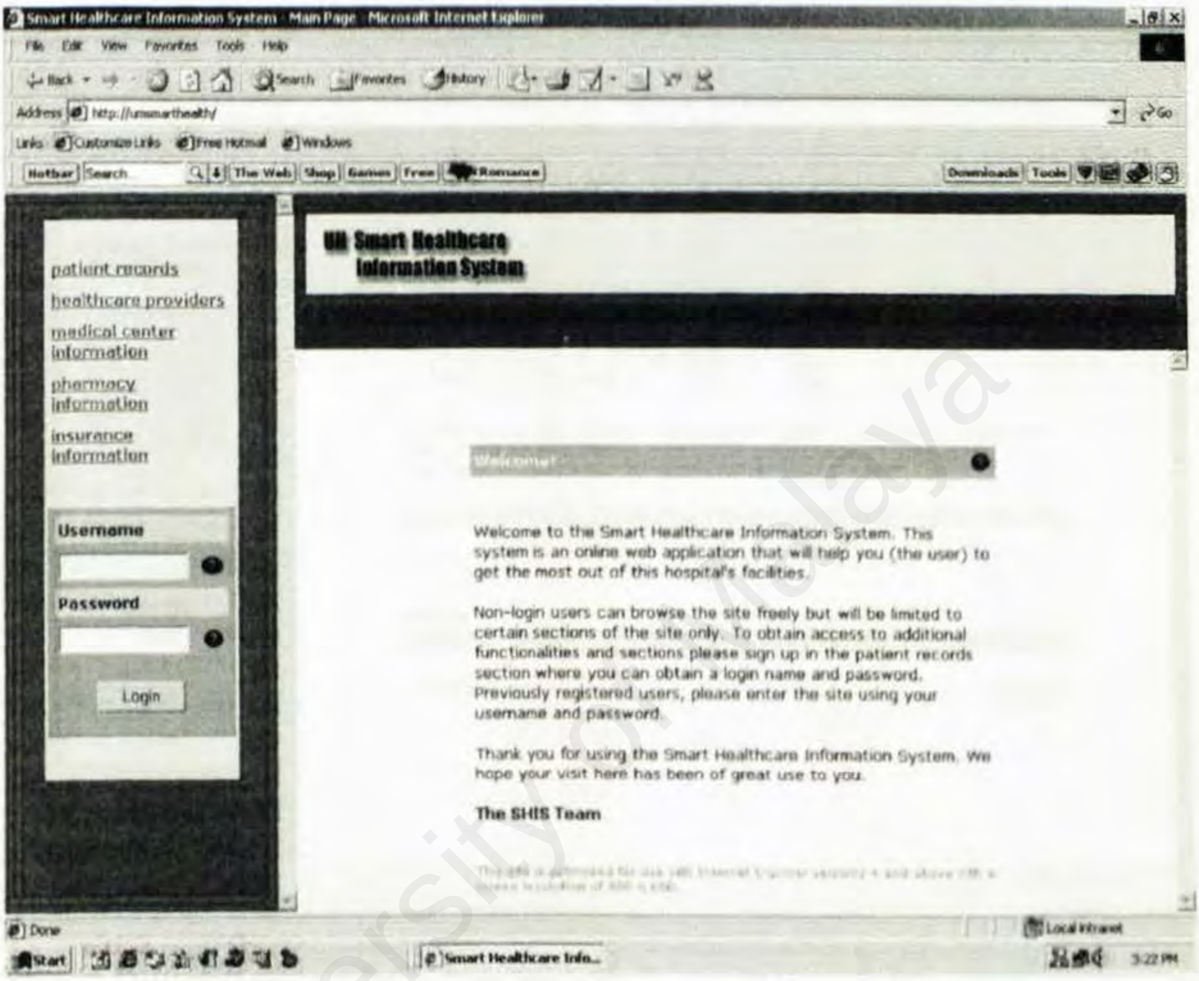
4.4 User Interface Design

For most users the interface is the "system". The objective of the interface design is to provide the best way for the user's to interact with the system. This way, they will be able to get the information they need in and out of the system.

The user interface design for this system is based on the Graphical User Interface (GUI) concept. Some of the Human – Computer Interface (HCI) general principles of designing an interactive system have been considered. Among these principles are responsiveness, recoverability, verification message, confirmation and consistency.

In this section, the main pages of each module will be shown together with the main page. These are the only selected ones because if all were to be shown it would be rather crowded. These other pages will be and have already been explained in lengthy detail in the user manual and system administrators manual that have been prepared separately and have not been included in this thesis. Those manuals have been prepared and have been binded separately respectively for ease in use. It would also help to reduce the bulkiness of this work itself.

4.4.1 The main menu


Smart Healthcare Information System - Main Page - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Address http://umsmarthealth/
Go
Links Customize Links Free Hotmail Windows
Hotbar Search The Web Shop Games Free Romance Downloads Tools
UM Smart Healthcare Information System
patient records
healthcare providers
medical center information
pharmacy information
insurance information
Username
Password
Login
Welcome!
Done
Local intranet
Start
Smart Healthcare Info...
3:22 PM

Welcome to the Smart Healthcare Information System. This system is an online web application that will help you (the user) to get the most out of this hospital's facilities.

Non-login users can browse the site freely but will be limited to certain sections of the site only. To obtain access to additional functionalities and sections please sign up in the patient records section where you can obtain a login name and password. Previously registered users, please enter the site using your username and password.

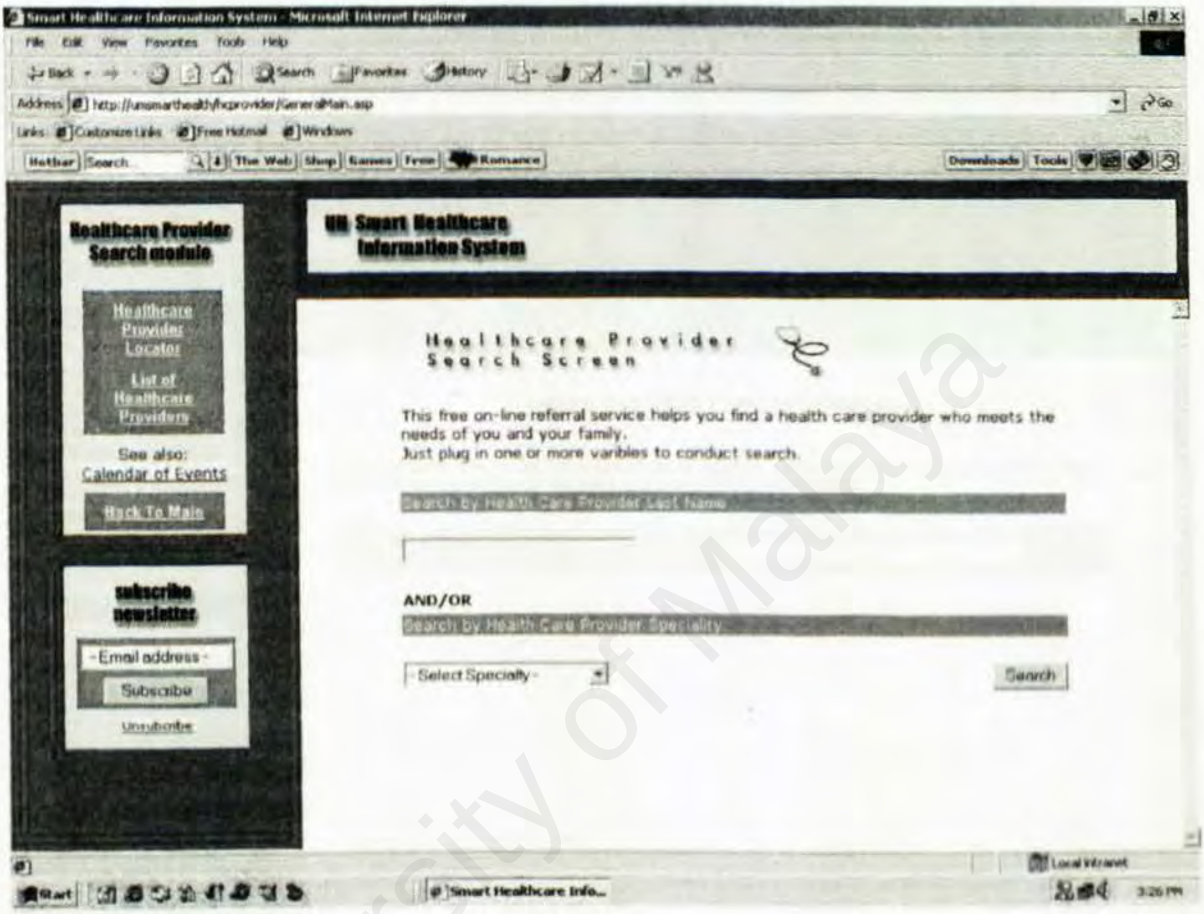
Thank you for using the Smart Healthcare Information System. We hope your visit here has been of great use to you.

The SHIS Team

This site is optimised for use with Internet Explorer version 4 and above with a screen resolution of 800 x 600.

Figure 4.7: The main menu's interface

4.4.2 The Health Care Provider Information System's Main Menu


Smart Healthcare Information System - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Address http://unsmarthealth/hcprovider/GeneralMain.asp
Go
Links Customize Links Free Hotmail Windows
Hotbar Search The Web Shop Games Free Romance Downloads Tools
Healthcare Provider Search module
Healthcare Provider Locator
List of Healthcare Providers
See also:
Calendar of Events
Back To Main
subscribe newsletter
- Email address -
Subscribe
Unsubscribe
UM Smart Healthcare Information System
Healthcare Provider Search Screen
Local intranet
Start
Smart Healthcare Info...
3:26 PM

This free on-line referral service helps you find a health care provider who meets the needs of you and your family.
Just plug in one or more varibles to conduct search.

Search by Health Care Provider Last Name

AND/OR

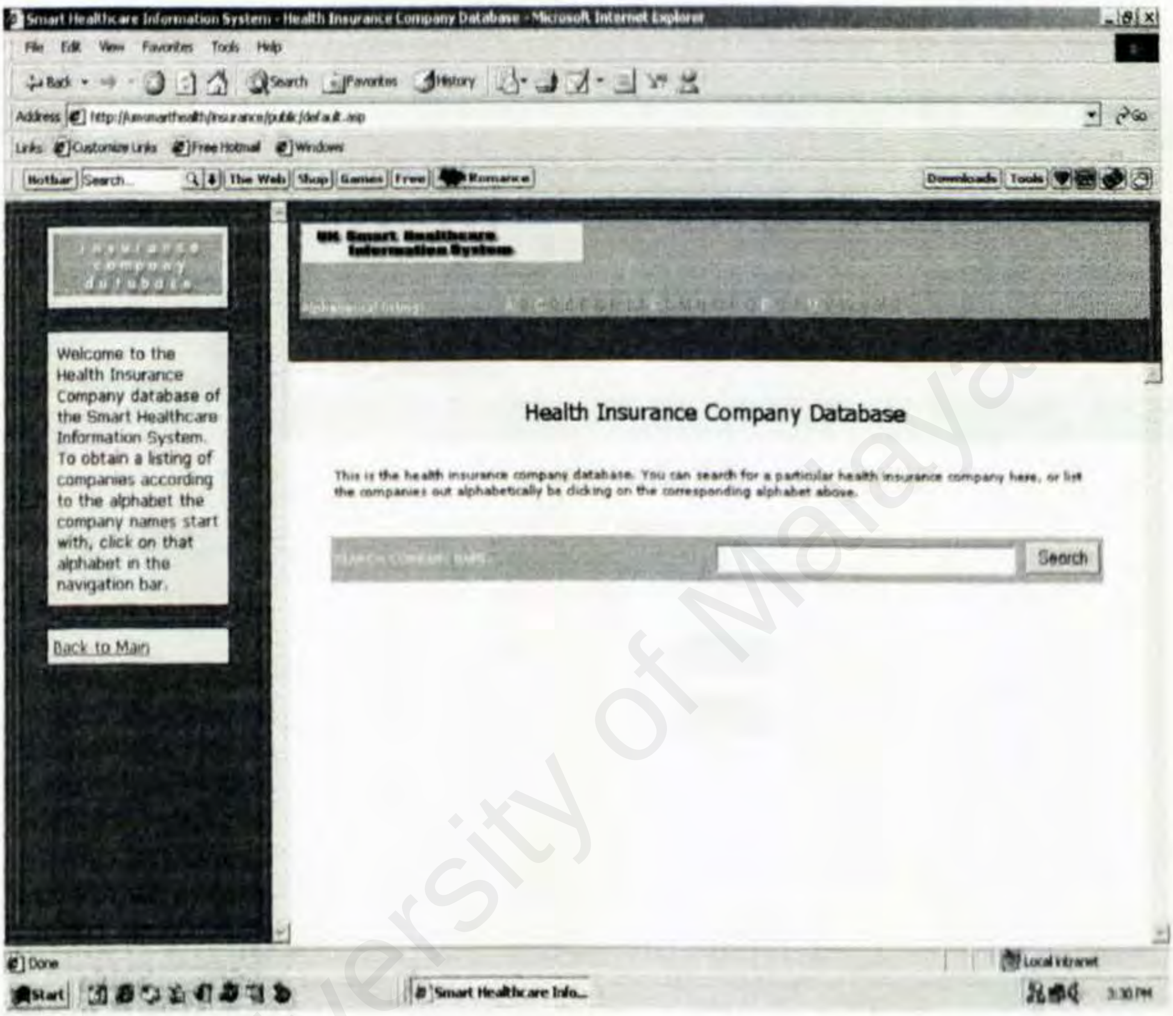
Search by Health Care Provider Speciality

- Select Specialty -

Search

Figure 4.8: The Health Care Information System's Main Menu

4.4.3 Health Insurance Information and Billing System's Main Menu


Smart Healthcare Information System - Health Insurance Company Database - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Address http://umsmarthealth/insurance/public/default.asp
Go
Links Customize Links Free Hotmail Windows
Hotbar Search... The Web Shop Games Free Romance
Downloads Tools
insurance company database
UK Smart Healthcare Information System
Alphabetical listing:
Back to Main
Search
Done
Local intranet
Start
Smart Healthcare Info...
3:30 PM

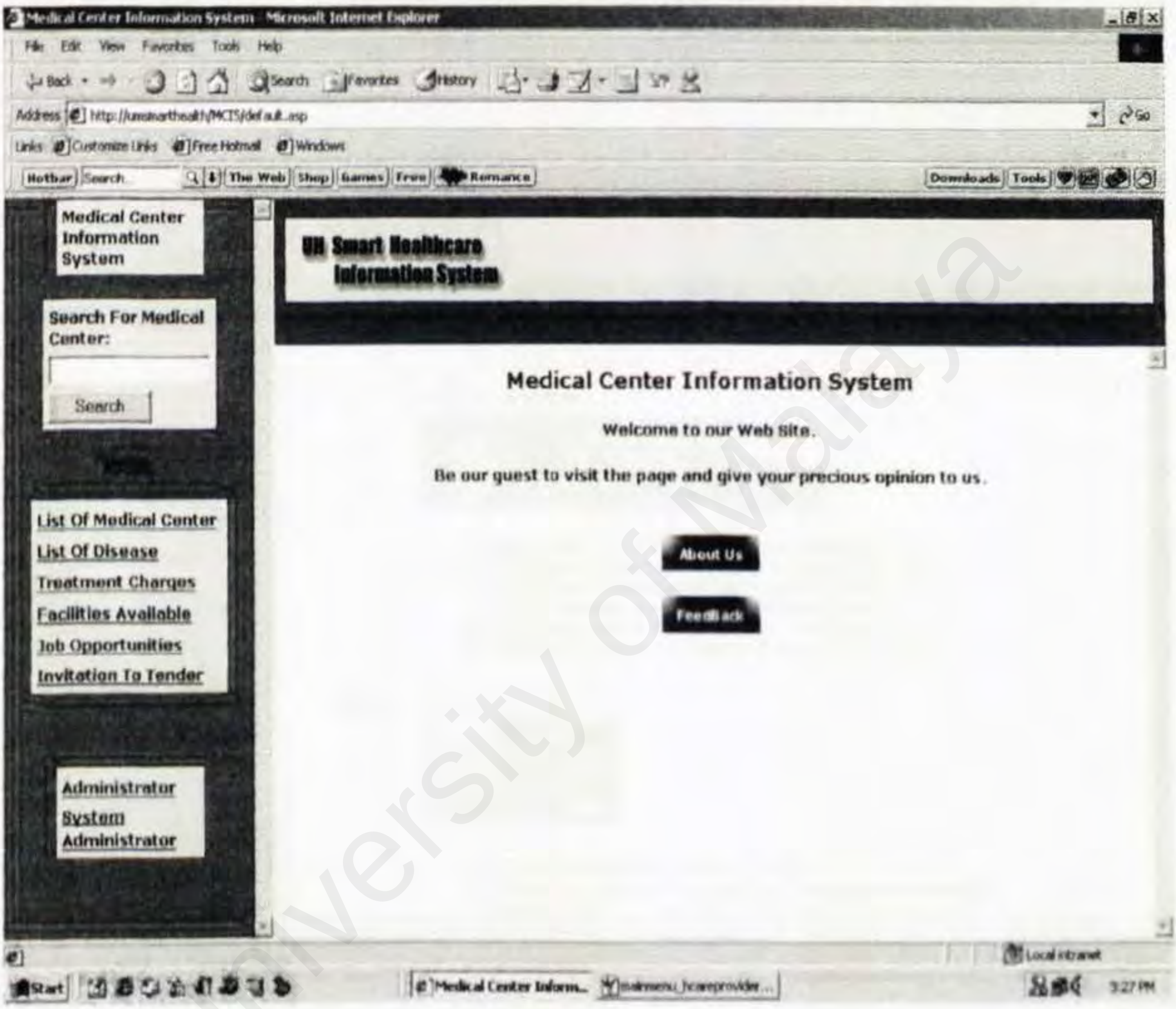
Welcome to the Health Insurance Company database of the Smart Healthcare Information System. To obtain a listing of companies according to the alphabet the company names start with, click on that alphabet in the navigation bar.

Health Insurance Company Database

This is the health insurance company database. You can search for a particular health insurance company here, or list the companies out alphabetically be dicking on the corresponding alphabet above.

Figure 4.9: Health Insurance Information and Billing System's Main Menu

4.4.4 Medical Center Information System's Main Menu


Medical Center Information System - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Address http://umsmarthealth/MCIS/default.asp
Go
Links Customize Links Free Hotmail Windows
Medical Center Information System
Search For Medical Center:
Search
List Of Medical Center
List Of Disease
Treatment Charges
Facilities Available
Job Opportunities
Invitation To Tender
Administrator
System Administrator
UM Smart Healthcare Information System
About Us
Feedback
Local intranet
Start
Medical Center Inform...
mainmenu_hcareprovider...
3:27 PM

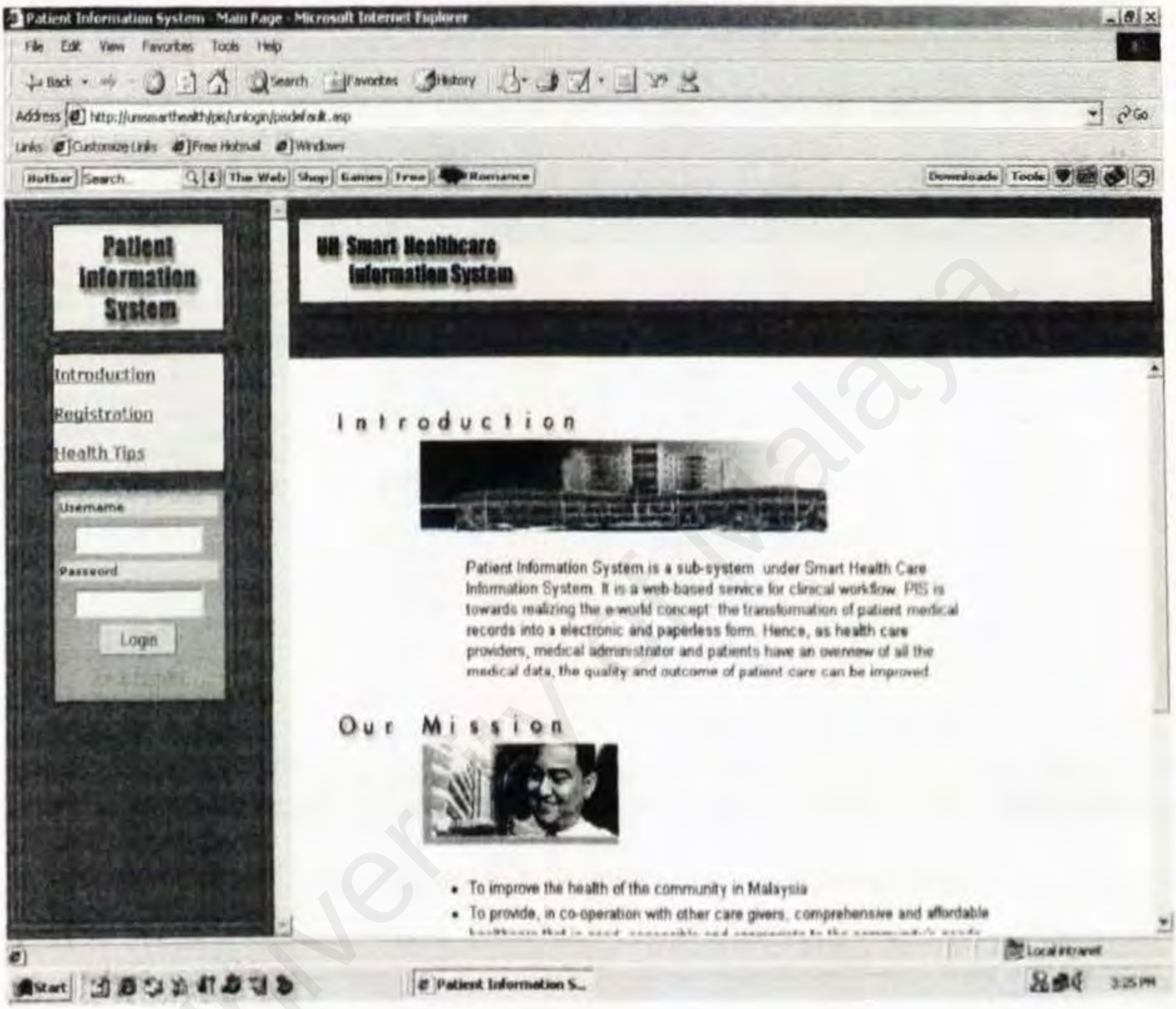
Medical Center Information System

Welcome to our Web Site.

Be our guest to visit the page and give your precious opinion to us.

Figure 4.11: Medical Center Information System's Main Menu

4.4.5 Patient Information System's Main Menu


Patient Information System - Main Page - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Address http://umsmarthealth/pis/unlogin/pisdefault.asp
Go
Links Customize Links Free Hotmail Windows
Hotbar Search The Web Shop Games Free Romance Downloads Tools
Local intranet
Start
Patient Information S...
3:25 PM

Patient Information System

UM Smart Healthcare Information System

Introduction

Registration

Health Tips

Username

Password

Login

Introduction

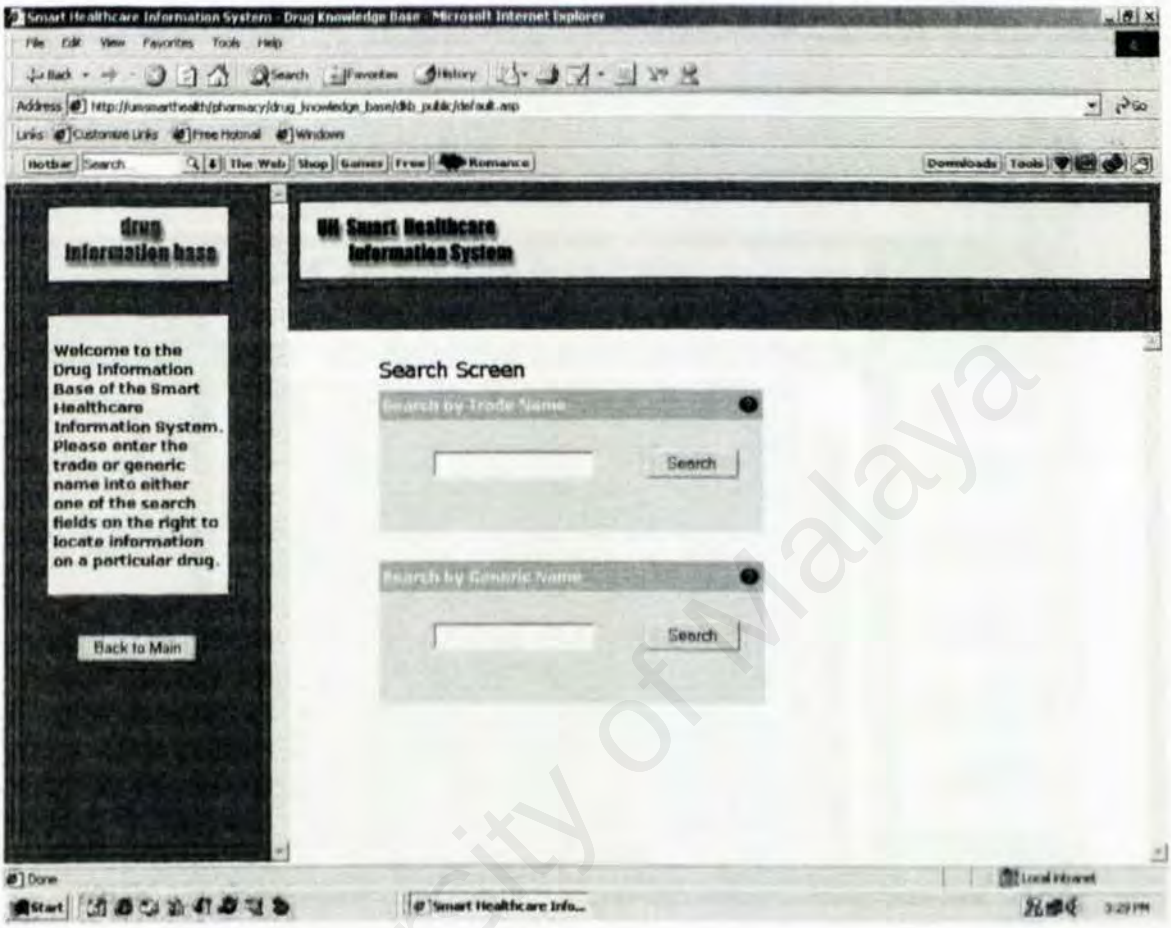
Patient Information System is a sub-system under Smart Health Care Information System. It is a web-based service for clinical workflow. PIS is towards realizing the e-world concept: the transformation of patient medical records into a electronic and paperless form. Hence, as health care providers, medical administrator and patients have an overview of all the medical data, the quality and outcome of patient care can be improved.

Our Mission

- To improve the health of the community in Malaysia
- To provide, in co-operation with other care givers, comprehensive and affordable

Figure 4.11: Patient Information System's Main Menu

4.4.6 Pharmacy Management System's Main Menu



Smart Healthcare Information System - Drug Knowledge Base - Microsoft Internet Explorer

Address http://umsmarthealth/pharmacy/drug_knowledge_base/dkb_public/default.asp

drug information base

UM Smart Healthcare Information System

Welcome to the Drug Information Base of the Smart Healthcare Information System. Please enter the trade or generic name into either one of the search fields on the right to locate information on a particular drug.

Search Screen

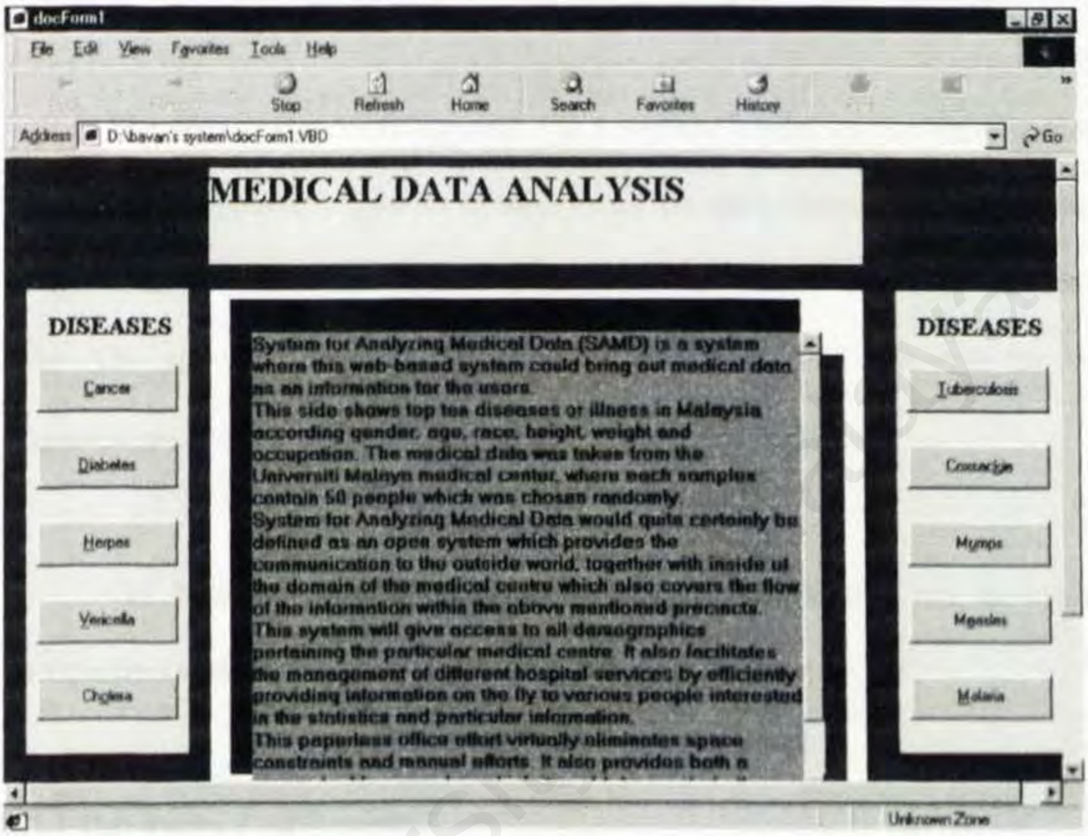
Search by Trade Name

Search by Generic Name

File Edit View Favorites Tools Help
Back Search Favorites History
Links Customize Links Free Hotmail Windows
Hotbar Search The Web Shop Games Free Romance Downloads Tools
Go
Search
Search
Back to Main
Done
Local intranet
Start
Smart Healthcare Info...

Figure 4.12: Pharmacy Management System's Main Menu

4.4.7 System for Analysing Medical Data's Main Menu



System for Analyzing Medical Data (SAMD) is a system where this web-based system could bring out medical data as an information for the users.

This side shows top ten diseases or illness in Malaysia according gender, age, race, height, weight and occupation. The medical data was taken from the Universiti Malaya medical center, where each samples contain 50 people which was chosen randomly.

System for Analyzing Medical Data would quite certainly be defined as an open system which provides the communication to the outside world, together with inside of the domain of the medical centre which also covers the flow of the information within the above mentioned precincts.

This system will give access to all demographics pertaining the particular medical centre. It also facilitates the management of different hospital services by efficiently providing information on the fly to various people interested in the statistics and particular information.

This paperless office effort virtually eliminates space constraints and manual efforts. It also provides both a

Figure 4.13 System for Analysing Medical Data's Main Menu

5.0 System Implementation

5.1 Development Environment

The development environment has a certain impact on the development of a system. The choice of a right set of tools to get the work done is very important, either in software or in hardware. This will influence the success rate of the project a great deal. The system implementation itself is a process that converts the system's requirements and designs into functional program codes real time.

The hardware and software tools used in this process are as below in a summarized version.

5.1.1 Hardware requirements

The hardware specification of the machine on which this was developed is:

Server	Workstations
• Running on Windows 2000 Server, Internet Information Server 5.0 and Microsoft SQL Server 7.0.	• Running on Windows 98 or Windows 2000 Professional, Visual InterDev 6.0, Internet Explorer 5.0 and Personal Web Server (Win 9) or Internet Information Server 5.0 (Win 2000)

• Two hard disks are present with 256 MB RAM. • A Pentium processor 7733 Mhz and a Network Interface Card with Ethernet 10/100 Mbps.	• A 15GB hard disk with 128 MB RAM. • Pentium 733 Mhz processor and an Ethernet with 10/100 Mbps with a Network Interface Card.

Table 5.0 : Hardware requirements

5.1.2 Software tools requirements

- **Application coding tools** (Microsoft Visual InterDev 6.0) – Creates and refines web pages for the whole system. (Microsoft Internet Information Server 5.0) – Maps local directory to virtual directory and creates a local web site.
- **Database implementation tools** (SQL Query Analyzer) – Generates database tables using SQL statements. (SQL 7.0 Enterprise Manager) – View and edit tables created in the database. The relationships between the tables can be viewed.
- **Graphics/Interface Modeling Tool** (Adobe Photoshop 5.5) – Graphics quality is maximized and can be created too. (Macromedia Dreamweaver) – Creating and editing web site interface design is simplified.

5.2 Installation of the system

Development tools installations are the very first steps in getting off with any development work together with the installations of the servers. The sequence of product installations sometimes can be important to ensure the smooth running of the programs, especially when it concerns the Microsoft products.

The installation process on the server is as follows:

1. Windows 2000.
2. Microsoft SQL Server 7.0.

Then, followed by those on the workstations:

1. Windows 2000 and Windows 98 (Sequence does not matter here).
2. Microsoft SQL Server 7.0
3. Microsoft Visual Studio 6.0
4. Adobe Photoshop 5.0
5. Macromedia Dreamweaver.
6. Microsoft Office with Front Page 2000.

5.2.1 Creating database

Below are the steps in which a database is created using the Enterprise Manager:

Enterprise manager is opened, a server group is expanded and then the server in which the database is wished to be created is expanded

↓

On database, right click and then click New database

↓

The database's name is typed, and for our integration project, the name is smarthealth

↓

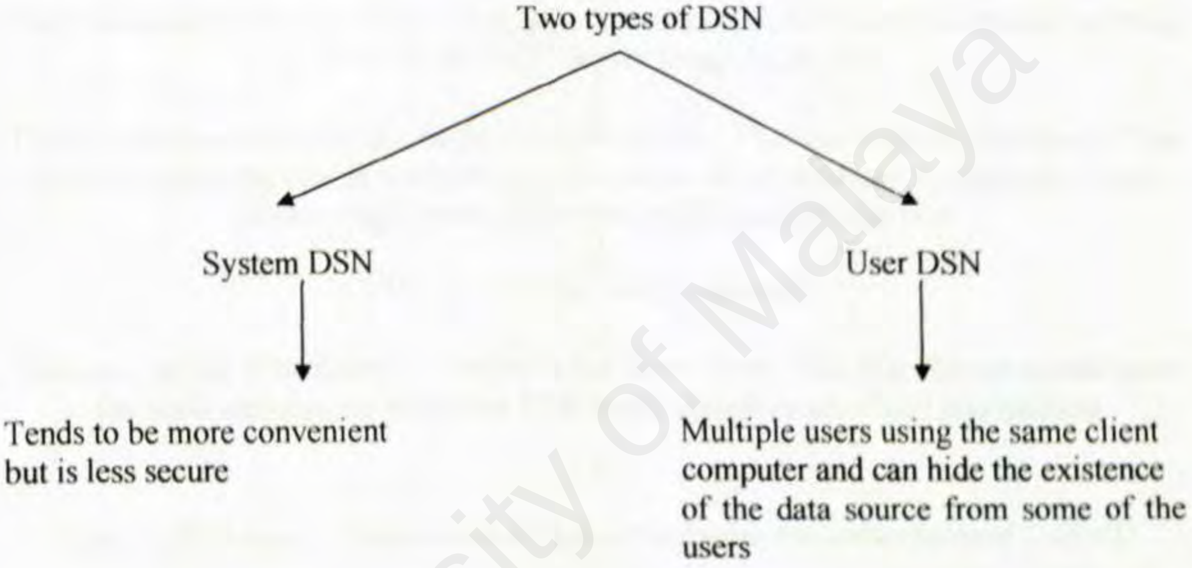
Now, inside a newly created database, right click on Users to create New Database User

↓

A login name and username is entered which follows by the assignation of the Database Role membership for the user created

5.2.2 Creating Data Source Name (DSN)

A DSN is needed to open connection to the database server. What is a DSN? It is actually a method of standardizing database connectivity. There are two types of DSN. They are illustrated below:

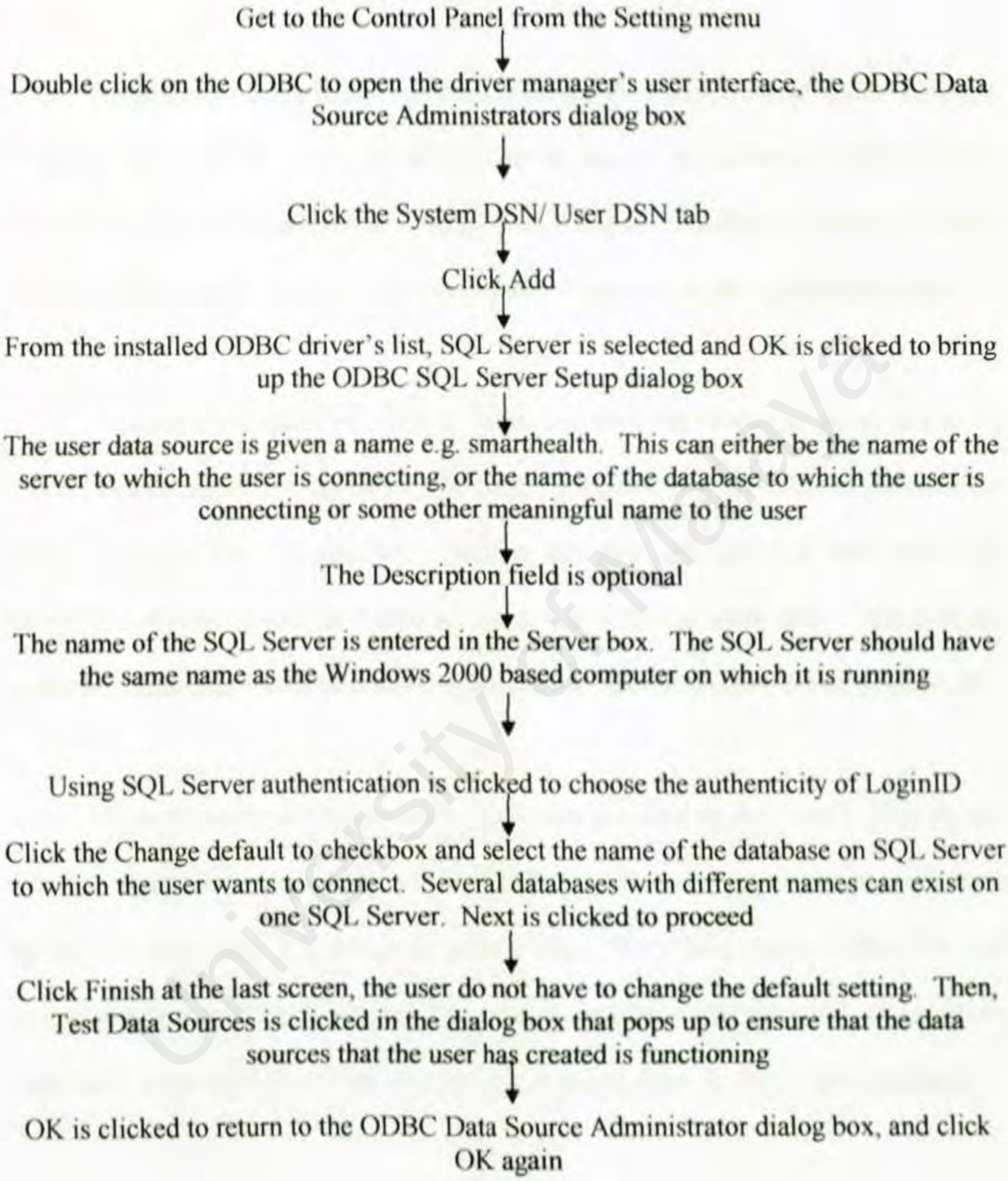


Tends to be more convenient but is less secure

Multiple users using the same client computer and can hide the existence of the data source from some of the users

Figure 5.0: Two types of DSN

Here are the steps taken to create either a system or user DSN:



Get to the Control Panel from the Setting menu

Double click on the ODBC to open the driver manager's user interface, the ODBC Data Source Administrators dialog box

Click the System DSN/ User DSN tab

Click Add

From the installed ODBC driver's list, SQL Server is selected and OK is clicked to bring up the ODBC SQL Server Setup dialog box

The user data source is given a name e.g. smarthealth. This can either be the name of the server to which the user is connecting, or the name of the database to which the user is connecting or some other meaningful name to the user

The Description field is optional

The name of the SQL Server is entered in the Server box. The SQL Server should have the same name as the Windows 2000 based computer on which it is running

Using SQL Server authentication is clicked to choose the authenticity of LoginID

Click the Change default to checkbox and select the name of the database on SQL Server to which the user wants to connect. Several databases with different names can exist on one SQL Server. Next is clicked to proceed

Click Finish at the last screen, the user do not have to change the default setting. Then, Test Data Sources is clicked in the dialog box that pops up to ensure that the data sources that the user has created is functioning

OK is clicked to return to the ODBC Data Source Administrator dialog box, and click OK again

Figure 5.1: Steps in creating a System / User DSN

5.2.3 Objects Coding

As this is an integration of several modules that have existing codes, only the fundamentals would be discussed in this concise report. By default, VBScript is the chosen language for scripting ASP objects. But, it's quite normal and customary to have a parody of languages, as long as they are specified properly in the application's page.

There are a number of ways in indicating that the blocks of script are to be executed on the server i.e. the server side code. One particular method is to surround the scripts with tags like <% and %>. Thus, in this case, any text that falls within the parameters of these would be treated as server side scripting commands. This is based on the language that would be defined at the beginning of the Active Server Page (ASP).

There are numerous handy built – in objects provided by ASP itself. This objects will help applications read requests from HTML forms, control the server, post results to the web browser, etc. It's simple to include these server side objects within the ASP scripts and the need of either initializing or declaring them will not arise. These above mentioned server side objects are *Application, Request, Session, Server* and *Response.*

An example of the coding that would require making a data connection and providing the emailing function is shown below. This example are taken from the Health Care Provider Information System module.

- **Data Connection**

```
Dim oConn, oRS

Set oConn = Server.CreateObject("ADODB.Connection")

Set oRS = Server.CreateObject("ADODB.Recordset")

oConn.ConnectionString ="DSN=smarthealth;UID=smarthealth;PWD=he@lthc@re"

oConn.Open
```

The above codes are used to make a connection between the web server and the database in order for retrieving and adding data be made possible.

- **Emailing**

```
Set objCDOMail = Server.CreateObject("CDONTS.NewMail")

objCDOMail.From = "<webmaster@smarthealth.com>"

objCDOMail.To = MailRec("Email_Add")

objCDOMail.Subject = strSubject

objCDOMail.Body = strBody

objCDOMail.Importance = 1 (o=Low, 1=Normal, 2=High)

obj.CDOMail.Send
```

Above is the important part of Mailer.asp that enables emailing for the Newsletter function in the project.

6.0 System Testing

Testing provides a way to uncover logical errors within the system and also to test the system's reliability. There are undoubtedly a variety of tests that are present depending on the subject of the tests, which can range from components and groups of components to an entire system.

Among the main reasons as to why testing was carried out was as below:

1. Bug tracking
2. Regression testing
3. Bug detection
4. Bug eradication (if any exist)

6.1 Unit Testing

Unit testing concentrates on the smallest component of the system for testing. Every individual component was tested individually, to ensure they operated correctly. For example, these components could be anything from checking the validity of input value for email address to parsing a sentence into each individual word etc.

Each sub module of every module was tested to make sure problems were not present, like bugs. Artificial but acceptable test values were entered into each form that accepts data from the user so that user input into the system could be tested.

Thus, unit testing was completed. Logical dependencies were also tested. Test values were included in the code so that the testing of every important logical statement that would access a particular segment of code could be done.

Logical dependencies were omitted at the sub module level itself. This was done by taking a few precautionary steps. Code segments were rearranged and loop structures were examined as utterly as possible to make certain that all code segments could be reached and would work as expected. Dependencies and their effects were determined by scrutinizing data and logical structures that exist in the code being developed.

Two types of unit testing were carried out in this integration project. They are shown as follows:

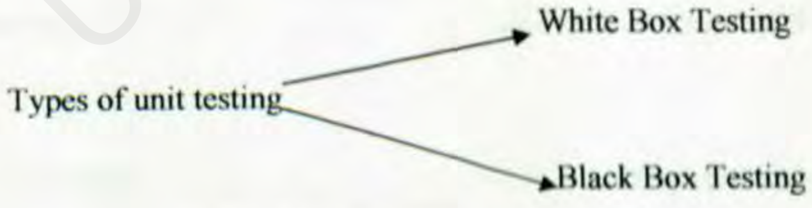


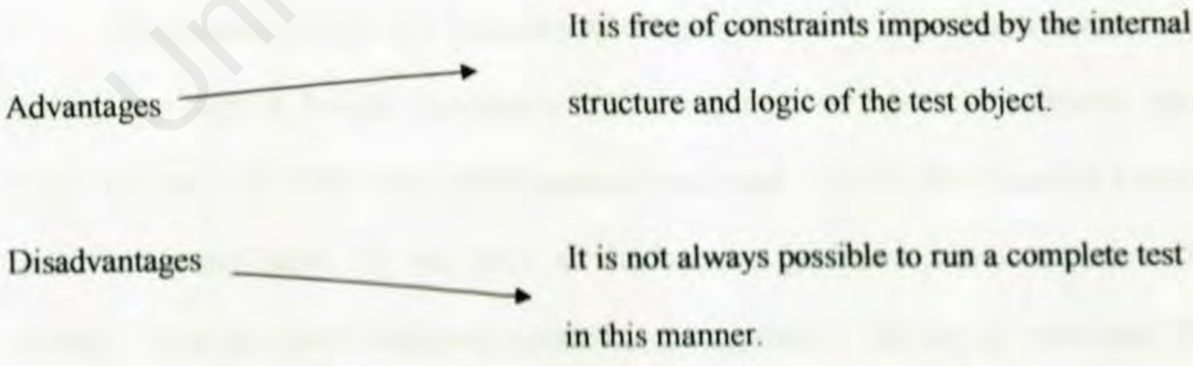
Figure 6.0: Two types of unit testing

6.1.1 White Box Testing

This ubiquitous mode of testing involves the analyzing of the code and the usage of knowledge regarding the structure of a component in deriving test data. The upper hand gained in using this type of testing is that an analysis of the code can be used to find out how many test cases are required to guarantee a given level of test coverage. The testing includes path testing, data flow testing, basic path testing and also loop testing.

6.1.2 Black Box Testing

By studying its inputs and the related objects, one can determine the test object's behavior. The types of tests that were carried out during this phase included domain testing, boundary value analysis and error guessing. The advantages and disadvantages of this type of testing are as follows:



Advantages

It is free of constraints imposed by the internal structure and logic of the test object.

Disadvantages

It is not always possible to run a complete test in this manner.

Figure 6.1: The advantages and disadvantages of black box testing

6.2 Integration Testing

This step called integration testing is actually done once the entire unit testing has been done. Although in the IntSHIS unit testing was done, there wasn't much impediments encountered to it. This was because most of the modules were already tested and were functioning quite normally already. But, this does not mean that no adjustments were required. Some fine tuning had occurred.

Much more attention was given to integration testing, though. This was undoubtedly due to the fact that this thesis takes the integration of its sub modules as one of the integral part of its research.

Integration testing, also known as modular testing, basically revolves around the verification of all the components working together as par with the description rendered in the system design specifications.

The system (SHIS), is a hierarchy of components. It is where each component belongs to a layer of design. Among the different approaches one could undertake, the Top – Down – Individual Integration approach was used. This is where testing begins from the top and works its way down as the branches get more convoluted for each module. Thus, the name Individual is added to the approach. The process continues till all the modules and sub modules have been tested.

6.3 Complete System Testing

This type of testing was given the most prominance and importance. This is done to uncover any limitations to the system itself, gauge its capabilities and make sure that the entire system is working according to users' specifications.

If the users' are satisfied with the system characteristics, the system is ready to be deployed for use. But, if there is a need for change, system modifications would be meted out to meet the users' expectations and requirements to the specifications and functionalities.

The result would indicate whether or not the complete system specifications and objectives have been met. Among the types of testing involved are fundamental, functional and further functional tests.

6.3.1 Fundamental Tests

There are number of these tests that are difficult to measure with some amount of precision. These tests are usually treated as complements to the individual functional and further functional tests. These functional tests would be explained briefly in the next section. For now, the fundamental tests are introduced below:

1. Performance – The main criteria that is seen here is the response time. Performance tests are conducted to make certain that the system's response time is met by user expectations and also that it doesn't exceed the predetermined performance criteria under heavy volume and stress of all sorts. The purpose of performance tests is also to test run the performance of various functions of the software within a specified hardware configuration. Stress testing can be added to the above explained test.

2. Reliability – Reliability testing is monitoring the mean time between failures. According to mathematical models of software reliability, the reliability tests are conducted. Consistency and reliability testing are parallel particularly when the system behavior is measured for consistency. For example, inputs, outputs and response time.

3. Serviceability – This is regarding the ability of the support personnel manning the phone line to acquire enough information to enable the maintenance organization to asses the error and fix it without additional information in the event of a crash of the user's software system.

4. Usability – This usually concerns the fact that building user interfaces that have pattern already familiar to the typical user. The interface should not be something totally new, which would require much scrutinizing from the user. A familiar surrounding which would lead the user to then use the software through pattern matching and paradigm shifts, something which everyone would do whilst mastering a product is in progress.

5. Install ability – A gauge to measure the difficulty for a novice in installing the software correctly and without many impediments independently.

6.3.2 Further Functional Tests

As mentioned in the preceding section, fundamental tests usually complement the further functional tests. These tests involve the following areas:

- Documentation testing – all examples used in the user's manual is tested for accuracy and whether the manual reports the correct answers when users obtain when they run the examples.

- The event list – All the functions are tested by one or more events in the event lists. Also all the possible triggers is exercised and the expected results are compared with the actual results. This would be able to indicate the variances present.

- Error message testing – Every error message that can be generated from the system is removed from the codes and put in a table. This is so that it could be tested for understandability and appropriateness.

7.0 System Evaluation

7.1 System Strength

This system has some strength of its own when compared to other existing medical web sites although to some extent it does not boast some powerful features. Among the conspicuous strength that it does possess are:

- Simple and user friendly interface – the user interface is easy to understand and friendly. Not much graphics and information is posted on any one page. So, less memorizing is required on the users' part. The learning curves are relatively simple and a user should be able to use the system within minutes with ease.

- User ID and password – All the modules are protected with passwords and ID's. Thus, unauthorized users are prohibited from viewing and modifying its records. This is quite important in an environment like that of a medical center where most of the records are actually very sensitive, personal information.

- Transparency – the system on the whole is transparent. Therefore, users do not need to know the intricacies of it, for example where the database resides or how the system is structured. Modification of databases is not required. All they need to do is to type in their keywords and view the query results.

- Reliable system with effective error recovery – This is a very reliable system as it caters for almost any possible errors that it may encounter. Server side scripting will generate proper feedback to user when error occurs. For instance, when a wrong password is typed, it is handled by the system which would then generate a friendly and simple to understand message indicating the nature of the error.

- Online editing of demography data – This system is the pioneer health web site in Malaysia, which allows registered users to update their demography data and also upload their passport sized photograph. All this is made possible online. It should be noted that most of the leading sites in the world doesn't support this feature.

- Instant appointment confirmation – Once a request for an appointment slot is made, the user would receive the results immediately as to whether that slot is vacant or not. This saves lots of time, money and is hassle free.

- Notification mail is auto-generated to registered users – The system would automatically generate notification mail and send it to users who have registered to the Patient Information System successfully.

- Interaction – Users have the chance of sending their feedback to the system administrator about anything concerning the service and this allows the system administrator to check and then replying it.

7.2 System Limitations

- Email checking – The system was unable to validate an email address in terms of deliverability. It only checked for the inclusion of an @, a . and a com. Once it had met the above requirements, it was considered a valid address.

- Performance level – The performance can be adjusted in the IIS but it is still very much dependant on the Internet connection speed and the bandwidth of the phone line.

- No encryption – The passwords are not encrypted. Thus, high vulnerability of the password arises from this. To combat this to some extent, the icon to save the password for future reference on the browser is not made available. This is to prevent malicious-willed people from using programs such as Password Revealer v1.5 and so forth from obtaining unauthorized entry to the system.

- Appointment system – The appointment system is largely based on the specialty despite of the date and time criteria to make certain the availability of appointment time slot. This utterly mean user would not have a choice of choosing the preferred physicians.

- The search engine – It doesn't support and is not capable of handling multiple keywords and implementing Boolean characters like AND and OR. Although it can return accurate searches, however, it can not search if multiple keywords are provided. The healthcare provider search engine is not capable of context sensitive searching. This will result of producing irrelevant hits in the query against the database.

- Deletion – The administrator section is not provided with a batch delete function. This means the administrator is required to delete database record one at a time.

- The newsletter – The newsletter function only alerts the subscribers of new event entry. If any new alteration is done to the existing events, no additional newsletter would be sent.

7.3 Problems and Solutions

Throughout this thesis, a number of obstacles were encountered which surfaced parallel with the development of the project. They would be discussed to some extent below:

- **The system analysis phase**

Since there was no prior knowledge and experience in developing a system, it was rather difficult to determine the scope of the system. This was even more so where the time frame was supposed to be met. This was then overcome after analyzing and studying the capabilities of Visual InterDev and ASP technology in particular. It's like finding out the speed at which one can travel so that the distance that could be covered at the end of the given time could be estimated.

- **The designing phase**

The applying of theoretical information gathered in the previous phase into practical use is no doubt a major problem one can face. Due to the lack of experience in designing systems, it was difficult to apply the best solution in a design. Browsing through the Net and previous modules' work was seen to be very informative yet helpful and was somewhat like an unseen guide.

- **The implementation phase**

As mentioned prior to this, no earlier knowledge in ASP proved to be difficult when scrutinizing the codes of the respective modules. Most of the modules were written with differing styles and structure with missing indentation where the codes were concerned. It is said that it is sometimes easier to start from scratch then to modify someone else's work.

The importance given during programming sessions in the university regarding readability and structure was proven here. As most of the pages were re-coded during the integration process, almost all the pages were modified to some extent. The main area that was stressed was the layout and color. The problems during database integration too were solved. This proved the SQL Server's credibility.

Technical problems that were not familiar with had to be solved through a number of ways. Among the many were, reading reference books, the aid from supervisor, friends and also through the Net. Some IT related sites had offered newsletters upon free subscription. This too was done. For example, the www.it-world.com site.

7.4 Future enhancements

No system is perfect and room for improvement exists always depending on the varying needs and expectations towards it. Among the ways of improving this particular system are:

- The administrators section – This feature is not equipped with a search function for the personnel to look up a database record. So, a search function that satisfies this concept should be developed.

- The system mail – Currently, due to time constraint and other more important phases that had required attention, the system mail sending function is supported by SMTP, which is integrated with Windows 2000. This way of implementation could be improved greatly by using Microsoft Exchange Server. This is undoubtedly a much more proper and superior manner of handling the mail sending function.

- Browsing through database records – The system now only allows the user to maneuver back and fro through the database records (for administrators) and search result (for general users) page by page. It would be an attractive feature if the user is allowed to jump via pages according to the individual liking and motive. This would speed up web browsing and database maintenance as well.

- The patient records – The records in this system is not fully computerized due to the fact that some test results like X-rays, CT scans and such are not available in the database. Because of the amount of work required to transfer these files to digital formats, and the doubt whether the medical centers would like to go to that detail, this feature has been left out and is open for enhancement.

8.0 Summary and Conclusion

Most of the currently available healthcare (or hospital) information systems in the country do not provide integrated services to users (e.g., hospital staff, patients) and they are also not web-based. As such, they are not flexible enough to meet current healthcare needs. Thus there is a need for an integrated, web-based healthcare information system, which is the purpose of this project.

The Smart Healthcare Information System (SHIS) is a web-based system that provides integrated services which allow users (e.g., administrators, nurses, patients, general public) to interact with the system and perform their tasks more effectively and efficiently and access the information they need from the system. For example, the system allows patients to view their personal records, to view prices of drugs, or make appointments online. It also incorporates security features so that only authorized users are allowed access to confidential information.

It is noted that while programming skills are essential, good practice on software engineering techniques must also be applied efficiently. This project would provide excellent opportunity on applying of the theoretical part of Systems Analysis and Design ideas, architectural designing, testing techniques, database designing and data modeling.

DFD's have been created after having done research on all the modules individually. The design of the system only depicts a general view of the IntSHIS. The diagrams do not give a detailed account of the workings of the different modules but it shows as to how the modules fit into the system.

During the literature survey phase, the information and data on the current Web technologies such as ASP concepts, search engines, client-server architecture, security issues, Cold Fusion and CGI sheds light on how the technologies function. The Integration of Smart Healthcare Information System (IntSHIS) system is implemented using Microsoft Windows 2000 Professional Server, Internet Information Server 5, and SQL Server 7 platforms. It also uses other tools, which includes Visual Studio 6, Microsoft FrontPage, Flash 5, Dream Weaver 3, Adobe Photoshop 6, and STATA (a statistical package). The scripts for server and clients are written in VBScript and Java Script.

Users can access to system either in non-login and login mode. In the non-login mode, users can browse the modules for general (i.e., non-confidential information) such as services provided, resources available, and information about upcoming events. The amount of information that a user can access in this mode varies from module to module.

In the login mode, users can access all the above as well access confidential information but only as it applies to them. In other words, users can only access the information that they are authorized to access. For example, a patient can only view (and possibly modify) his or her record but not other patients' information. The login is by username and password.

The Smart Health Care Information System (SHIS) is an integrated web-based healthcare information system designed to improve and enhance the services provided by hospitals and medical centers. It consists of six modules (subsystems) as follows:

- Patient Information System
- Pharmaceutical Information System
- Medical Center Information System
- Health Insurance Information and Billing System
- Health Care Providers Information System
- System for Analysing Medical Data

All the modules have a uniform interface, i.e., they all look alike. The functionalities of the modules are as follows:

Patient Records Module

- allows patients to register online
- allows access to health tips
- allows users to change appointments

Pharmacy Management Module

- provides information on drugs
- provides information on stock levels
- allows editing of prescription data
- allows editing of drug data

Medical Center Information Module

- provides general information about medical centers and the facilities available in each center such as treatment charges, job opportunities, and invitation to tender
- allows users to login as system administrator and apply changes to any of the available services

Insurance Information Module

- provides a list of insurance companies which are affiliated with the medical center

Health Care Information Module

- provides a list of healthcare providers
- provides a healthcare provider locator
- provides a calendar of events
- provides subscription to newsletter

System for Analysing Medical Data Module

- provides interface to the statistical package STATA which can be used to perform a variety of statistical analyses on the medical data.

This integrated web-based healthcare information system can be used to improve the services provided by hospitals and medical centers. Although SHIS is quite generic, the needs of individual hospitals and medical centers need to be studied in detail before the system can be implemented.

Note: *The user manual for normal users, administrators and system administrators has been created and is not included in this report due to the bulkiness of its nature and its function here. Thus, the user manual is with the system where the user requires it.*

Appendix I: REFERENCES

BOOKS

1. Federov, Alex, "**Professional Active Server Pages 2.0**", 1st Edition, United States of America, Wrox Press, 1998.

2. Vieira, Robert, "**Professional SQL Server 7.0 Programming**", Wrox Press Ltd., 1999.

3. Alka Jarvis and Vern Crandall, "**Inroads to Software Quality, How to Guide and Toolkit**", Prentice Hall, 1997.

4. Kendall & Kendall, "**System Analysis and Design**", 4th Edition, United States of America, Prentice Hall, 1999.

5. Shari Lawrence Pfleeger, "**Software Engineering Theory and Practice**", 1st Edition, United States of America, Prentice Hall, 1998.

6. Sellappan, P., "**Software Engineering Management & Methods**", Malaysia, Sejana Publishing, 2000.

7. Raymond McLeod Jr., "**Management Information Systems**", Prentice Hall, United States of America, 1998.

8. Eric A. Smith, "**Active Server Pages Bible**", IDG books, United States of America, 1999.

9. M. Morris Mano, "**Digital Design**", Prentice Hall, United States of America, 1991.

10. David B. Bromilow, "**MIMS Annual Malaysia DIMS 1997/1998**", 8th Edition, MediMedia International Group, Phillippines, 1997.

WEBSITES

1. Internet Design Magazine www.idm.internet.com

2. The Apache Software Foundation www.apache.org

3. Programmer's Resource www.programmersresource

4. ASP Alliance.com www.aspalliance.com

5. The Sun Java Website java.sun.com

6. San Jan Jacinto Methodist Hospital System

(http://www.methodisthealth.com/sanjacinto/index)

7. Cape Fear Valley Health System

(http://www.capefearvally.com/link.htm)

8. Saint Barnabas Health Care System

(http://www.saintbarnabas.com/)

9. Medpearl (Nashville, Tennesse)

(http://www.medpearl.com)

10. Baylor Health System

(http://www.baylorhealth.com)

11. http://www.superexpert.com

12. http://www.planet-source-code.com

13. http://www.mgh.org/

14. http://www.pcmag.com

15. http://www.asp101.com

16. http://www.microsoft.com

Appendix II: ACRONYMS

ADO	**ActiveX Data Objects**
ASP	**Active Server pages**
CDO	**Collaboration Data Objects**
CGI	**Common Gateway Interface**
DBMS	**Database Management Systems**
DFD	**Data Flow Diagrams**
DLL	**Dynamic Link Library**
DSN	**Data Source Name**
ERD	**Entity Relationship Diagram**
GIF	**Graphics Interchange Format**
GUI	**Graphical User Interface**
HCI	**Human Computer Interface**
HTML	**Hypertext Markup Language**
HTTP	**Hypertext Transfer Protocol**
IE	**Microsoft Internet Explorer**
IntSHIS	**Integration of Smart Health Care Information Systems**
IS	**Information System**
IIS	**Internet Information Server**
ISAPI	**Internet Server Application Programming Interface**
JPEG	**Joint Photographic Experts Group**
Ms	**Microsoft**

NIC	**Network Interface Card**
ODBC	**Open Database Connectivity**
SQL	**Structured Query Language**
SHIS	**Smart Healthcare Information System**
SMTP	**Simple Mail Transfer Protocol**
URL	**Uniform Resource Locator**
VBScript	**Visual Basic Scripting Tool**
WWW	**World Wide Web**