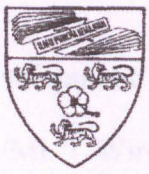


UNIVERSITI MALAYA

PROJEK ILMIAH TAHAP AKHIR II
WAP WEB SEARCH ENGINE
(WapFCSIT)

By :

SHARIFFAH ANN ZARINA BT. SYED AHMAD JAMALULIL
WEK 990424
SESI 2002/2003

FACULTY OF COMPUTER SCIENCE AND INFORMATION TECHNOLOGY

Submission date :
16 January 2003

Supervisor:
PUAN RAJA JAMILAH BT. RAJA YUSOF
Moderator:
MR. PHANG KEAT KEONG

ABSTRACT

This proposal is focusing on the development of WAP (Wireless Application Protocol) Web Search Engine using WML (Wireless Markup Language) as the domain programming language. The purpose of WAP is to allow people to create and view web pages on wireless devices such as mobile phones or within handheld computers like the Palm. A WAP search engine system is designed for lower bandwidth and small screen viewing while using the ordinary search engine through a wireless device may not be possible or inconvenient. The objective of this project is to develop a search system to enable the users to navigate or browse on the information about FCSIT (The Faculty of Computer Science and Information Technology).

In this WAP search system, there are two options in finding the FCSIT information. There are hyperlink option and the search option. Both options are capable in retrieving information based on different topics. The scope of this project is to retrieve information about FCSIT such as to check the lecturer's email and the semester schedules. To view the search system in a real WAP environment, a simulator and an online WAP browser will be used. The target audiences will be among the student of FCSIT, the lecturers and other people who need to retrieve data on FCSIT. The Waterfall Model is chosen as the methodology to build up this system. The UP.Simulator and Nokia WAP Toolkit will be used as the tools to develop the WAP search system. From the early phase until the finishing phase, the duration of the system development is planned from 24th June 2002 until 7th February 2003.

ACKNOWLEDGEMENTS

BismillahHirahmanirahim...

First and foremost, I would like to thank Allah for giving me the strength and patience to do this project development and everything else in my life. All my effort on this project development are for His glory and not my own.

Next, I would like to extend my sincere appreciation and immense gratitude to Puan Raja Jamilah Bt. Raja Yusof for taking me under her wings. She has been a terrific supervisor in giving me encouragement, support and guidance. My next heartfelt thanks goes to my moderator, Mr. Phang Keat Keong, for his patience and positive criticism which enabled me to work out my flaws in my project and help me to produce better achievements in the success of my system.

This success would not have been accomplished if this project were being done individually without help and guidance from others. Many thanks to my friends and to those who had help me by giving ideas and suggestions during the development of the proposal. It is impossible to list here all those who helped to sustain me during the writing and revising, and I apologize in advanced for any omissions.

Last but not least, I would like to express my enormous thank you to my mother, Puan Zaidah Bt. Abd. Rahman and my family for giving me the love, courage and support endlessly. This thesis is especially dedicated to the loving memory of my late father, Syed Ahmad Jamalulil Bin Syed Sohor Jamalulil.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES AND CHARTS

CHAPTER 1 : INTRODUCTION

1.0 Project Background

WAP is climbing rapidly in the technology world. Statistics have shown that more people are switching to WAP technology compare to the previous years and it is undeniably that WAP has a promising future and a good prospect in this cyber century.

The Internet and the mobile phone, the two rapidly increasing technology phenomena of recent years, have joined together. WAP have signified this convergence. It is merely an enabling technology, a collection of rules for altering Internet information so it can be displayed on a small screen of a mobile phone.

The aim of WAP is to bridge the gap between the mobile world and the Internet as well as corporate intranets and offer the ability to deliver an unlimited range of mobile value-added services to subscribers – independent of their network, bearer and terminal. Mobile subscribers should be able to access the same wealth of information from a pocket-sized device as they can from a desktop.

WAP is a new face of the Internet. Basically, WAP allows for sites and applications to be created which can be display and run in mobile telephone or PDA (Personal Digital Assistant). WAP is a new technology but it is already starting to take off in a big way.

Imagine being able to do things that at the beginning, to take for granted over the Internet, from anywhere via a mobile phone. For instance, checking parcel that has been delivered on the way to a meeting, sending an email while traveling on the train, booking cinema tickets online, or find a recipe or play a game while yachting. These all can be done with the wireless technology.

Though, this is rather new at the moment and the phones that will allow to do this are only just starting to appear but with the big names phones all lined up behind WAP, it is only a matter of time. In the meantime, there are numbers of browser available which can browse a WAP sites from a computer or a Palm.

1.1 Project Definition

This project is about developing a WAP web search engine to find information about the FSCIT. There are three definitions to merge into one project definition. The three main definitions are :

1.1.1 What is WAP ?

WAP stands for Wireless Application Protocol. The Wireless Application Protocol is a global standard for bringing Internet content and services to mobile phones and other wireless terminals.

The WAP standards are maintained by an industry consortium called the WAP Forum. The idea comes from the wireless industry, from companies such as Openwave.com, Nokia and Ericsson. WAP Forum membership now exceeds 500

organizations, representing over 95 percent of the global handset market. The WAP Forum also includes members who are infrastructure providers, software companies and content providers. The goal of the WAP Forum is to address problems of wireless Internet access, ensuring that such access is not limited by bearer, vendor or underlying network technology. [Bennett, C. 2001]

The URL for authoritative source for WAP is http://www.wapforum.org/

1.1.2 What is WML ?

WML stands for Wireless Markup Language and it is the HTML-like language used to design Wireless Application Protocol (WAP) pages and sites. These sites, in turn can be surfed by millions of mobile phones, PDAs and other wireless devices.

WML is a markup language based on XML (eXtensible Markup Language). XML is a set of rules for markup languages whose tags describe content instead of how the content is displayed (note that HTML does the opposite – it defines the display without regard for content type). These tags are defined in a set of "rules" called a document type definition, or DTD. In the case of WML, the WAP Forum has created a DTD to define the tags describing the content to be sent to your phone. Thus, a WML document is an XML document that adheres to the specific DTD set up by the WAP Forum.

All XML-based code must begin with a *header* that identifies the codes as XML-based and contains a reference to the appropriate DTD. Since a WML document is an

XML document, a programmer must reference the DTD in the header. The code that follows is the standard WML header that should appear as the first two lines of the coding. It defines the location of the official WML DTD, located on the WAP Forum's web site as shown in table 1.0 :

Table 1.0 : The WML Document Type Definition (DTD).

```
<?xml version="1.0"?>
<!DOCTYPE wml PUBLIC "-//WAPFORUM//DTD WML 1.1//EN"
http://www.wapforum.org/DTD/wml_1.1.xml>
```

The WAP Forum provides information about the WML DTD at http://www.wapforum.org/ [Foo, Soo Mee *et al*, 2001]

This specification defines the syntax, variables, and elements used in a valid WML file. The actual WML 1.1 Document Type Definition (DTD) is available for those familiar with XML at : http://www.wap-uk.com/Developers/Tutorial.htm

Just like HTML and XML, WML is read and interpreted by a browser built into the WAP device. For WAP devices, the browser is commonly called a micro browser, indicating that its capabilities are somewhat limited. These capabilities are also limited to the capabilities of the WAP device in which it lives.

1.1.3 What is Search engine ?

WAP web search engine is a search engine for WAP sites and WAP resources. The search engine is used for more than one use :

- Navigation – finding websites
- Surfing
- Searching for information or content

This means that search engine traffic has a different value for each user. Understanding what is profitable is the ultimate purpose.

1.2 Project Objectives

1) To bring internet content and to develop a wireless navigation surrounding to wireless handsets and other wireless terminals.
2) To focus on information finding about FCSIT using a search engine system that are going to be developed using wireless protocol specification to work across differing wireless network technologies.
4) To give extra facility to the users especially to the resident of FCSIT to retrieve information while on the move, through an application being hosted in a web server.
5) Defines and tests the search engine service where user can find information about FCSIT according to his geographical criteria from different information sources.

6) The implementation supports terminals capable to read WML and other languages that support WAP.

7) Fast way to communicate – beneficial when finding information on FCSIT without any attached wire in a short time span.

8) WAP web search engine is accessible through a wireless devices at all time, therefore, it is best for users who are always on the go and they would not be bounded by location to find any information.

1.3 Project Scope

The coverage of the project as in what is the limitations of the wireless devices and what are the boundaries set upon the application. These limitations have serious implications for the way of designing the WAP application.

a. The system is designed for the use by people who need to retrieve information about FCSIT when they do not have access to an Internet linked computer.

b. The information is focusing in retrieving FCSIT data and other links to find information globally. The links will direct the user to the URL of the links page.

c. In the WAP search system there will be only two ways to find information. The options are the hyperlink option and the search option.

d. To build up the system using WML as a domain language. Other than WML, the system will be using some other languages used as a minor

for example WML Script, HTML, XHTML and other languages to support the WAP web.

e. In the actual environment, WAP devices (e.g. PDA, mobile phone) are the tools needed. However, for this WAP web search engine project, an online WAP browser will be used instead of the PDA and the simulator will be functioning to view the WAP search page instead of the mobile phone and gateway. The online WAP browser and the simulator will enable direct access to the web server and encoding the WML. The simulation must be performed in the Windows based platform because most of the useful simulators can only be run in Windows based platform.

f. The limitations of the WAP devices-less powerful CPU, less memory (ROM,RAM), smaller displays, different input devices.

g. The speed of data transmission rates is approximately 9.6 kilobits per second which is much slower compare to fixed line connections.

h. The cost of WAP is higher compare to normal dial-up connection. The normal dial-up Internet connection is RM 0.025 per minute all day. The following table shows the mobile access fees for WAP : -

Table 1.1 : Mobile Access fees for WAP.

Peak rate (9 am to 7 pm)	RM 0.30 per minute
Off Peak rate (7 pm to 12 am)	RM 0.15 per minute
Super Off Peak (12 am to 9 am)	RM 0.025 per minute

1.3.1 Target group

The target group for this system is among users that need to be at any places. In other words, users who need to retrieve information on FCSIT while on the move. To do this, we use wireless technology.

The target group that are using WAP in searching information would be among the student of FCSIT, the lecturers, the UM staffs and other people who need to know on the information about the FCSIT.

Apart from that, IT professionals, students from other faculty in UM or students from other universities might be some of the small percentage targeted in the target group who would want to find information on the FCSIT.

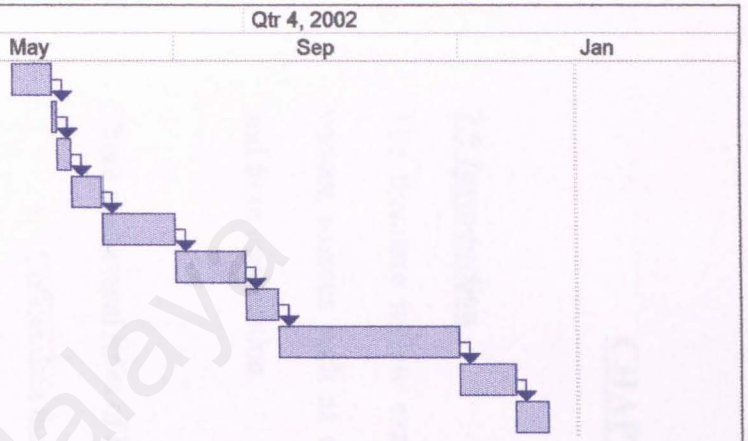
1.4 Project Schedule

Table 1.2 : Phases descriptions.

Phases	Activities
1. Early review and system requirements analysis	- Determine system objectives - Determine system requirements/needs - Provide project schedule - Choose model for system development
2. System design	- System interface design
3. Program design	- Determine the expected outcome
4. Documentation I	- Provide manual for early phases
5. Coding	- Learning WML - Learning SQL, Microsoft Access - Implementing the codes
6. Unit and integration system	- Design test data - Testing modules - Compare test result with the real result
7. System maintenance	- Improved changes for data
8. Documentation II	- Provide manual for final phases

Table 1.2 is showing the description of the phases in the project schedule. Figure 1.0 is depicting the Gantt Chart for the project schedule using the Microsoft Project 2000 as the software to develop the chart.

ID	Task Name	Duration	Start	Finish
1	Early Research and Analysis	13 days	Mon 24/06/02	Wed 10/07/02
2	Topic Confirmation	2 days	Thu 11/07/02	Fri 12/07/02
3	Project Objectives	5 days	Sat 13/07/02	Thu 18/07/02
4	Finding Information	9 days	Fri 19/07/02	Wed 31/07/02
5	System Design	23 days	Thu 01/08/02	Sat 31/08/02
6	Program Design	22 days	Sun 01/09/02	Mon 30/09/02
7	Documentation I	10 days	Tue 01/10/02	Mon 14/10/02
8	Coding	57 days	Tue 15/10/02	Tue 31/12/02
9	System testing	18 days	Wed 01/01/03	Fri 24/01/03
10	Documentation II	11 days	Sat 25/01/03	Fri 07/02/03



Project: Project Schedule
Date: Thu 20/02/03

Task
Split
Progress
Milestone
Summary
Project Summary
External Tasks
External Milestone
Deadline

Figure 1.0 : Gantt Chart for Project Schedule.

CHAPTER 2 : LITERATURE REVIEW

2.0 Introduction

The literature review examined for WAP Web Search Engine system came from various sources such as distributing form of questionnaires, conducting interviews and from observation.

There are several roles of literature review that has been identified:

- Collect data that are related to the system that is going to be developed.
- Evaluation and reviews of systems that uses the same concept or relevant to the concept has been developed to determine the weakness and the strength of the system and to improve the weakness that has been identified.
- To get a better idea of the concept involved in the search system that is going to be developed while comparing several other existing software that will be used to produce the best result and solution.

2.1 Information source and finding methods

There are a few ways of finding the information about WAP web search engine to gather details needed to analyze the system, to know the user's requirements on the system and everything about WAP technologies basically.

The methods/material in findings the information are :

I. Questionnaires

II. Interviews

III. Observation

IV. Articles from media

V. Internet

VI. Group discussion

VII. Reference books

2.1.1 Questionnaires

A simple form of questionnaires were distributed among the student of Computer Science and Information Technology (FCSIT) UM and other users. The questionnaires is about the WAP technology, whether WAP search engine is beneficial to FCSIT students or not and what kind of information they normally search for.

2.1.2 Interviews

The respondent for the interviews are among the student of FCSIT, student that are related to IT and to the people that have used the WAP technology to search for information. This help to identify and to understand the problems that may arise when the system is developed. Informal interviews were also conducted from time to time to gather more information and opinions on the system that is going to be developed.

2.1.3 Observation

Observations were carried out on individuals/student who owned wireless devices to determine the amount of them that are going to use the WAP web search engine system. Careful evaluation has also been made to compare the system that exists and how it operates.

2.1.4 Articles from media

The newspaper is usually the common media to find about computer related information. There are many articles about the WAP technology which sometimes are available up to three or four times a week. Normally, the articles are collected from two main newspapers :

a) Computimes (New Straits Times)

b) In Tech (The Star)

2.1.5 Internet

The Internet was fully utilized, as this was an excellent source of information. The resources from surfing the Internet has helped a lot in the success of developing the WAP web search engine. Various of the information retrieved from the Internet is about the specifications of WAP, how the language is being implemented (WML), the language syntax, and about the existing WAP web search engine for an example to develop this project.

2.1.6 Group discussion

Group discussion were formed among other student that involved in completing their thesis to discuss the details about the importance of the system and the implementation processes. The discussions have gathered various opinion from the student and the viewpoint were analyzed.

2.1.7 Reference books

Books are used in finding the relevant information about the WAP and other information to help in completing this project. The books are usually for the reference on the coding and the implementation of the system.

Examples of books for reference :

a) Practical WAP

b) Professional ASP Data Access

c) Professional WAP

d) Software Engineering

e) Deitel & Deitel How to Program

f) Dynamic WAP Application Development

g) Systems Analysis and Design

h) UML Explained

i) Wireless Internet & Mobile Business – How to Program

2.2 The existing WAP search systems

There are many existing system developed for the purpose of searching information through WAP technology because it is designed for lower bandwidth, small screen viewing and it is more convenient. A few examples of WAP web search engine are :

a) FAST Mobile Search

b) WAPLY

c) WAPJAG

d) Mopilot

e) Wapsilon

f) Gelon.net

g) Somewherenear.com

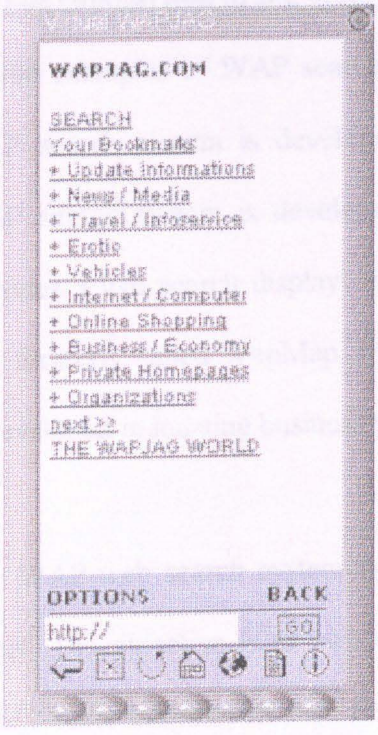


Figure 2.0 : Online WAP browser

Figure 2.1 : Simulator

The figure 2.0 is showing an example of an online WAP browser. In this example, the online WAP browser is WAPJAG. Figure 2.1 is showing the example of a simulator to simulate WAP content as it is viewed in a real mobile phone.

2.3 The comparison of the WAP search systems

All the examples of WAP search system are different in many kind of ways. Every WAP search system is developed to meet different needs. For example, Mopilot WAP search system is developed to lists pages about WAP and WML and also provides a live search display of what WAP users are looking for, in short this site was formerly called WapMap. Meanwhile Somewherenear.com WAP search system is developed in locating businesses while on the move.

The WAP web search system that is developed in this project also have a different target. The objective is to build a WAP search system that can retrieve data about FCSIT basic information such as the calendar, the lecturer's email, the address where the faculty is situated and so on. This is very useful to the student or individual who needs to know information regarding FCSIT via their wireless devices.

All of the above WAP search engines are just the same in one way, that is to find information globally, mainly information based on WAP. Hence, the main comparison between the available WAP search engines that existed and the WAP search engine developed in this project is, in this WAP search system, the information that can be retrieved are focusing on the FCSIT data, while the other WAP search engines did not offer the ability to find information about the FCSIT. In a way, this system helps for specific group of users that have been explained earlier in Chapter 1.

2.4 The advantages of the WAP web search engine

As mentioned before it is useful to individual or student that need the information wirelessly. Since there is no WAP search system that has been built to retrieve information on FCSIT before, this would be an extra in information retrieval. The examples of data that can be retrieved from the database about the FCSIT are :

a) calendar – student can check the date when new semester is started, date of holidays, date of exams and date of events.
b) lecturer's email
c) the location of FCSIT – for individual/people that have business in FCSIT.
d) Other information – for examples, courses and majoring that are offered in FCSIT.
e) Other WAP links are also provided for the user who needs to find other information globally.

2.5 The disadvantages of the WAP web search system

There are a few disadvantages of the WAP search system :

1) The information is not global – the WAP search engine will only provide sources and information about FCSIT.
2) The information about FCSIT is not widen which means not every details about FCSIT are available. However, the users can find the content of information in the WAP search system and the details that are available through WAP browsing, in the search content displayed in the main page of the WAP web search system.

3) The number of students, lecturers, individual or people who are using WAP phone or any other wireless devices are limited, which means the system is not going to be widely used.

2.6 WAP Tools

A WAP application development platform contains a suite of tools to aid in the development process. The tools that are going to be used in developing the WAP web search system are divided into three categories :

I. Development Platforms

II. Development Server

III. Development Software

Table 2.0 : WAP tools.

WAP Tools	**Description**
SDK	The SDK contains tools such as, emulators, WML, and WMLScript compilers and editors.
Emulator	Most SDKs contain emulators to test the look and the feel of the application
Web server	Web server is essential for applications that use server-side scripts such as ASP and Java servlets.

Text editor	The WML text editors aid the developer in creating WML content.
WAP gateway	The WAP gateway forms a bridge between 2 distinct worlds, the Internet and the wireless phone/data network. The WAP gateway is optional for WAP development.
Mobile phone/wireless devices	Real devices are needed to test the application before deployment. But in this project, instead of the real devices, the simulator and an online WAP browser will be used.

Table 2.0 is the summarizes of the tools that make up a WAP development platform. The main steps involved in WAP application development are :

[Foo, Soo Mee *et al*, 2001]

- Developing the WAP application using the tools available. The minimum tool that is needed in this project is a text editor.
- Testing the application using available emulators. Emulators provide an easy and fast tool for debugging the application.
- Deploying an application by uploading the source into a live web server.

- A second round of testing is conducted to ensure that the application runs correctly under real-time condition.

2.6.1 Development Platforms

There are several development platforms can be used in developing the WAP web search engine system, such as :

a) Microsoft Windows 95/98/2000/NT

b) UNIX

c) LINUX

In this project, the development platform is Windows 2000. The windows is chosen because Windows operating system has a nicer GUI (Graphical User Interface) than LINUX and UNIX. It can be used in most of the emulators/development toolkits. It can only be run on windows platform. Furthermore, Windows 2000 professional comes in a package with IIS.

2.6.2 Development Server

The development server is important because when a user enter a URL (Uniform Resource Locator) address into the web browser, the web server will process the requested document from the URL and maps the URL to a file on the server and returned the requested document to the user. During this transaction, the web server and the user communicate using the platform-independent *HyperText Transfer Protocol* (HTTP), a protocol for transferring requests and files over the Internet. In

this WAP search system, the development server are quite variety. The examples are shown in the Table 2.1 :

[Deitel, H. M. *et al*, 2001]

a) Microsoft Internet Information Server (IIS)

b) Microsoft Personal Web Server (PWS)

c) APACHE Web Server

Table 2.1 : The description of the variety web servers.

IIS	**PWS**	**Apache**
License software but it is included with Windows 2000.	Freeware. Packaged with Microsoft IIS in NT 4.0 Option Pack. Also included in Windows 98.	Freeware
The most popular Web server for Windows 2000.	A basic Web server for publishing personal Web pages.	Currently the most popular Web server.
Platform : Windows 2000.	Platform : Windows 95/98/Millenium Edition/NT	Platform : UNIX, Windows NT/2000, experimentally supports Windows 95/98.
Easy to use.	Easy to use.	Difficult to use.

WAP server is not used in this project because this system is just a simulation application, instead a web server is being used. Though the APACHE server is a freeware and support more operating systems but APACHE server cannot support ASP in which this system will be using it as a database language. PWS is a scaled-down version of IIS, unable to perform as professional as the IIS. It is designed for small scale web development and therefore it is not suitable for this application. Hence, the IIS was chosen instead. The system is based on Windows 2000 and the IIS comes free in the package. Moreover, IIS is professional, commercial web server found on many hosting service.

In order for the web server to send files to the emulator in the correct format, we need to configure the MIME (Multipurpose Internet Mail Extensions) types. It is a standard used to differentiate between different types of content stored on the Internet. Table 2.2 is showing the MIME types.

Table 2.2 : The MIME types that need to be set up for serving WAP content

Description	**MIME Type**	**Associated Extension**
Plain WML file	text/vnd.wap.wml	.wml
Compiled WML file	application/vnd.wap.wmlc	.wmlc
WMLScript file	text/vnd.wap.wmlscript	.wmls
Compiled WMLScript file	application/vnd.wap.wmlscript	.wmlsc
Wireless Bitmap Image	image/vnd.wap.wbmp	.wbmp

MIME type configuration in IIS is available through the Internet Service Console. Here, we have the choice of setting MIME types for either the entire server, for individual web sites, or even for specific directories. For this project, setting them for the entire server is fine.

2.6.3 Development Software

To adapt with the WAP environment, a development software is used as a simulator. Some examples of the development software are :

a) UP.Simulator (Phone.com)
b) Nokia WAP Developer Toolkit
c) Ericsson Developer Toolkit

For this WAP search system, Nokia WAP SDK version 2.1 is used as the development software as it supports version 1.1 and 1.3. Most other emulators supports version 1.1.

2.7 Systems Development Lifecycle

Introduction

System development is a complex but a well-defined process. It is usually done in several stages – preliminary investigation, analysis and requirements capture, design, implementation and maintenance. The term system development life cycle (SDLC) is often used to describe these stages as shown in the figure 2.2. [Sellapan, P., 2000]

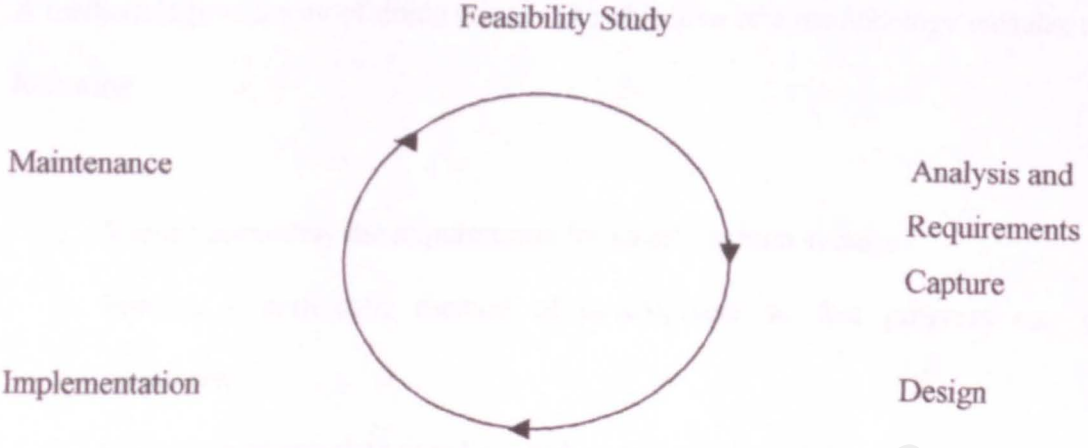


Figure 2.2 : System Development Life Cycle

The software engineering process consists of a set of steps that encompass methods, tools, and procedures. These steps are often referred to as software engineering paradigms or software life-cycle models. A paradigm for software engineering is chosen based on the nature of the project and applications, the methods and tools is to be used and the controls and deliverables that are required.

2.8 Introduction of Methodology

A methodology may be defined as a collection of procedures, techniques, tools and documentation aids. The procedures, techniques, tools and documentation help software developers to speed up and simplify the software development process. A methodology may consist of phases, which in turn may consist of sub-phases.

A methodology is a way of doing things. The objective of a methodology includes the following :

1. Record accurately the requirements for an information system.
2. Provide a systematic method of development so that progress can be monitored.
3. Provide an appropriate time limit and an acceptable budget.
4. Produce a system that is well documented and easy to maintain.
5. Provide an indication of needed changes as early as possible in the development process.
6. Provide a simple system so it would be easy for users to use.

After a literature review done as part of a system development process, this section is being done to explain regarding the development methodology of the system. The main purpose of this analysis is to help people understand the system that is going to be developed. The analysis done covers most aspect of strategy and paradigm that will be used in developing the system.

Several stage in project management that need to be completed:

- Determine project start time so that the next development activity can be done effectively.

- Plan the project properly where it explains in details activities and works need to be completed. Execution of every plan must be monitored and updated according to the information received.
- Execute the project according to what has been planned.
- Observed the project flow and make necessary changes if any part of the activity has a problem that cannot be solved or does not meet the original requirements.
- Project closing is where the project management ends and it shows that the project has achieved its objectives and fulfills its original requirements.

Analysis regarding the development tools that will be used is also being done. This analysis consists of reliablility factors and system reusability that is being developed from the aspect of hardware and suitable software.

2.9 System Development Methodology

Software engineering is important in organizing and executing the development of a system. Systematic analysis using *System Development Life Cycle* is a standard methodology to ensure the development process fulfills all the required aspects. The proper sequence of developing a system is called a life cycle that is implemented to ensure all individuals involved or interested to be involved in the project has the knowledge on how the system will be developed. This methodology is proven effective and it is still being used at the moment.

The development of a system using System Development Life Cycle is divided into several software process models such as the Waterfall Model, V Model, Prototyping Model, Transformational Model and other models. This WAP Web Search Engine will be developed using the Waterfall Model with Prototype used as a methodology guide. This model has several advantages over other models to ensure the development process is properly organized, high in quality and meets the standard. The advantages are: [Pfleeger, S. L., 2001]

a) Important stages in the development process can easily be recognized.
b) Easy to separate one stage from the other stage.
c) Presents a very high-level view of what goes on during development.
d) Easy to estimate period of time needed for an activity or stage.
e) Prototyping process is used to examine some aspect of the proposed system and decide whether it is suitable or appropriate for the finished products.
f) Validation ensures that the system has implemented all of the requirements, so that each system function can be traced back to a particular requirement in the specification.
g) Verification ensures that all function works correctly.

The phases that are involved in the methodology of the WAP web search engine are :

- Early review Phase
- System Analysis Phase

- System Design Phase
- Coding/Programming Phase
- Testing and Execution Phase

The project development phase is described in figure 2.3.

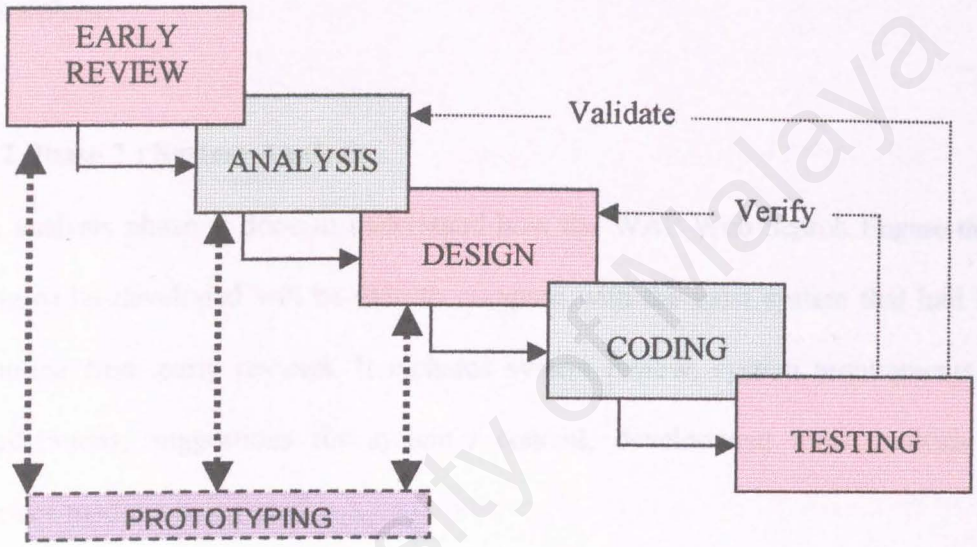


Figure 2.3 : Waterfall Model with Prototype.

2.9.1 Phase 1 : Early Review

This phase is also known as *feasibility study*. It could also be described as Investigation and Identification Phase.

Investigation and Identification Phase

At this point, early review is being done to gather information and description on the system that is going to be developed. This phase will give the definition for the objective of the WAP Web Search Engine system. Early investigation on the existing system has been done to identify the process involved in the existing system as well as the disadvantages and problems that arise. User's opinion is also being considered in this phase.

2.9.2 Phase 2 : System Analysis

The analysis phase is done to understand how the WAP Web Search Engine that is going to be developed will be able to compare with the exist system that had been identified from early reviews. It includes system review, system requirements and specifications, suggestions for system's content, development tools analysis and interface medium being used.

Further details on system analysis will be in Chapter 3.

2.9.3 Phase 3 : System Design

Design is the creative process that requires understanding and natural talent to transform the problem into a solution. It is being acquired by reviewing systems that exists. The description of a solution is also called design.

This phase involves explanation about the whole WAP web search system that is going to be developed and the expected system performance. In this phase, all of the

system properties such as system architecture, database design, process design and interface design are being explained. Menu design, content presentation, modules and database are parts of the properties that will be explained. This is done to simplify the interface developing process of the system that is going to be developed.

System Design will be further disscussed in Chapter 4.

2.9.4 Phase 4 : Coding/Programming

Programming is one of the most important aspects in developing a system. It will determine whether the system manage to achieve its objectives. This makes the development environment vital in completing the programming process. All analysis and reviews had been done in details to determine the most suitable environment in achieving the project objectives. Besides all that, 3 main aspects that are being emphasis on is control structures, algorithm and data structure.

This phase will be elaborated in the Chapter 5.

2.9.5 Phase 5 : Testing and Maintenance

Testing is done to ensure that the WAP web search system, functions as it was suppose to. It is done to detect faults in the system so that all the modules devloped are free from errors and the system can response to request effectively.

Testing is one of the most important elements to ensure whether the system developed will be able to fulfill user's requests. High quality system will be able to

handle any type of system testing. To achieve this, all specification, design and programs done during the system development stage will be reviewed and reevaluate.

This phase will be executed after the implementation phase or programming phase and will be futher explained in Chapter 6.

2.10 Conclusion

In conclusion, the literature review has covered up subtopics like the analysis and synthesis of the existing system, the analysis in developing the WAP web search engine system, the analysis of types of tools being used in developing the WAP search system and the analysis of the system development methodology.

CHAPTER 3 : SYSTEM REQUIREMENT ANALYSIS

3.0 Introduction

Requirements are identified, success measures documented and initial funding and project kick off conducted.

In this phase, the WAP Web Search Engine system will be studied and analyzed to gain an in-depth understanding of the system and assess its strengths and weaknesses in meeting the requirements.

3.1 System Requirements

One of the main purpose of analysis is to determine the requirements of users such as user interface, data entry screen and the information needed to be implemented in the database.

System Requirement Analysis can be divided into 2 sub-categories:

[Whitten, J. L. *et al*, 2001]

- Functional Requirements
- Non-Functional Requirements

3.1.1 Functional Requirements

Functional requirements are functions or system abilities. Functional requirements also explain the interaction between the system and its environments.

[Whitten, J. L. *et al*, 2001]

Browsing Function

This is a search mechanism that makes it easy for the student/users to find information they are interested in. The search engine has a simple, as well as clear and readable search options. Simple tasks like finding information based on keywords are handled by the simple search interface. The users just need to enter in the input area box and click the search button.

Hyperlink Function

There are two hyperlink functions. First is the other WAP search engines hyperlinks, where users can navigate the other information globally using the URL given. The second hyperlink is based on the information of FCSIT. The users can search for FCSIT information using the browsing method or the hyperlink method.

3.1.2 Non-Functional Requirements

Non-Functional requirements are limitations where system must operate to eliminate the limitation. Non-functional requirements for this system are as follows:

[Whitten, J. L. *et al*, 2001]

- *Reliability*

  This system is reliable and will not require a high maintenance cost if it is used according to the correct procedures.

- *Simplicity*

  Screens and instructions are organized properly so that it is much more easier for user to understand and use the system.

- *Effectiveness*

  This means that input and output screens have a specific purpose in the system.

- *Simple Interface*

  Simple interface is a vital aspect needed to encourage user to use the system. The WAP web search engine interface will be as simple as possible in its layout so that it can be used by the maximum numbers of people possible. Other than that, the simple interface is due to some of the constraints such as the small size screen for the wireless devices.

3.2 System Requirements Analysis

Decision on using the appropriate software for developing the system is important for system implementation. This is to ensure that the software is going to be used to develop this project is suitable with the concept of the project. This includes the main

software needed to develop the system and the software's required to support the system and extend the system's capability. The software's that is going to be used in developing this WAP Web Search Engine system are:

I) Nokia WAP Toolkit 2.1 – renders WML and WMLScript content for WAP applications.

II) Microsoft Access 2000

Nokia WAP Toolkit 2.1

To start writing WAP web search engine application, a developer toolkit is used. For this WAP search system, Nokia WAP Toolkit 2.1 is used as PC-based environment to write, test and de-bug the WAP application. There are many other developer toolkit such as Openwave and Ericsson, but Nokia Toolkit is a well-known and is more widely used. Therefore, it is more reliable since so many people are using it as a developer toolkit. With the Nokia Toolkit 2.1 a developer can create complete applications without the need for a handset or access to carrier infrastructure. Testing and demonstrating WAP applications is simple and straightforward because the developer can navigate and request URLs on either the Nokia WAP Server or on any web server on the Internet. In addition, applications can also be stored and queried directly from the PC file system. [Bennett, C., 2001]

Components of Nokia WAP Toolkit 2.0

- WML and WMLScript editors - for creating and editing static WML and WMLScript content.
- Device Simulator – running WML browsers for viewing WAP content.
- Debugging and testing tools – showing detailed information about the application execution.
- Sample application in source code to use a starting point.

Microsoft Access 2000 and ASP

After careful review of several systems that can be used to develop the system, Microsoft Access 2000 seems suitable to build the database for the information and details on the WAP web search engine page.

Microsoft Access is using SQL as the query language combined with the ASP language to retrieve the data or information from the database. Moreover, Microsoft Access is easy to learn and execute. The tables or query can be organized and inserted as part of a sheet into another sheet. Microsoft Access 2000 has some advantages listed below :

a) Combine every relation between tables.

b) Automation of task made easy.

c) Able to display tables systematically.

d) Query information in database.

ASP is a server-side technology and as such is browser-independent. Unlike client-side JavaScript or VBScript, which may or may not work depending on the user's browser, ASP is totally transparent to the web browser. In fact, ASP protects code from being scrutinized by anyone surfing the WAP site. The page that users see is always HTML since the server has done all the processing on the server-side. The ASP is platform independent, easier to learn, faster and easy to manage. The current release of ASP is version 3.0, available on Internet Information Server (IIS) version 5.0 running under Windows 2000.
[Foo, Soo Mee *et al*, 2001]

ASP is used to access data through ADO (ActiveX Data Objects). ASP is most closely associated with Windows NT and IIS as the third party port. ASP was initially shipped with version 3.0 of Microsoft Internet Information Server (IIS). When IIS receiving a request for a page with a.asp extension the following sequence of events occurs :
[Esposito, D. *et al*, 2000]

- Any server-side code that is embedded in the WML or HTML markup is executed.
- This second process, where the server executes nested scripting code, allows us to create pages on the fly. This enables us to add content to the page.

The power of ASP lies in 3 extremely important aspects :

- It makes building dynamic applications easy.
- It is simple, so developers can move over to ASP with ease and absolute beginners can pick up the concepts quickly.
- It lets developers make use of components to build complex web-based services.

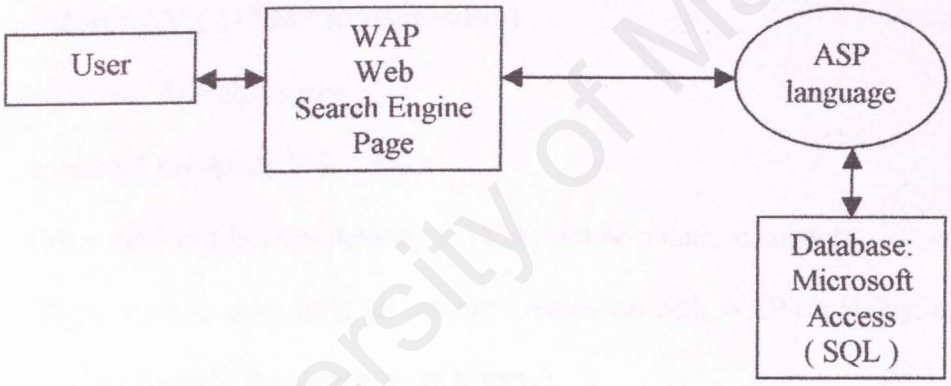


Figure 3.0 : The figure is showing the flows in retrieving information from the database.

Figure 3.0 : Flow chart showing information retrieval from a database. Once a user request/search an information from the WAP web search engine, the ASP language will retrieve that requested information from the database built in the Microsoft Access using the SQL command. When the data/information have been retrieved

from the database then the ASP will link back the information to the WAP web search engine page to display the required data to the user.

3.3 Hardware Requirements Analysis

Usually hardware refers to machinery or physical tools that perform basic functions in the process of operation cycle. Minimum specifications required to execute the WAP web search system are as follows:

- 300 MHz Pentium or faster processor
- 64MB RAM (128 MB recommended)
- 50 MB of free disk space
- Monitor (resolution 800 x 600)
- Other devices (besides desktop) : PDA, mobile phone, simulator
- All the devices must have an Internet connection with WAP capability, except for the simulator that runs with web server.

Devices Types

The WAP web search system has been designed to fit within the limitations of a low speed (9600 bps or slower) dial-up mobile telephone link and a low capacity hand held device. The result is a set of specifications which follow Internet standards as much as possible and meet the limitations set for them. However, the result is an additional set of standards, different to existing Internet and web use.

WML is designed to meet the constraints of a wide range of small, narrowband devices. These devices are primarily characterized in four ways:

- *Display size* - smaller screen size and resolution. A small mobile device such as a phone may only have a few lines of textual display, each line containing 8-12 characters.
- *Input devices* - a limited, or special-purpose input device. A phone typically has a numeric keypad and a few additional function-specific keys. A more sophisticated device may have software-programmable buttons, but may not have a mouse or other pointing device.
- *Computational resources* - low power CPU and small memory size; often limited by power constraints.
- *Narrowband network connectivity* - low bandwidth and high latency. Devices with 300bps to 10kbps network connections and 5-10 second round-trip latency are not uncommon.

This document uses the following terms to define broad classes of device functionality:

Phone - the typical display size ranges from two to ten lines. Input is usually accomplished with a combination of a numeric keypad and a few additional function keys. Computational resources and network throughput is typically limited, especially when compared with more general-purpose computer equipment.

PDA - a Personal Digital Assistant is a device with a broader range of capabilities. When used in this document, it specifically refers to devices with additional display and input characteristics. A PDA display often supports resolution in the range of 160x100 pixels. A PDA may support a pointing device, handwriting recognition and a variety of other advanced features.

The Limitations of Wireless Devices

- *Small screen* – In general, WAP devices are tiny. Those accustomed to web browsers will find navigating with a WAP phone a real pain.
- *Limited input facilities* – Most wireless devices lack a keyboard that is anything like a traditional QWERTY PC keyboard. Simple, mass-market, consumer-class data input technology that does not depend on a keyboard has yet to be invented.
- *Limited processor power and memory* – WAP browsers are simple and unforgiving.
- *Limited bandwidth* – At this stage, WAP devices have very little bandwidth available when compared to PCs. In Europe, users can count on a speed 9600 bps (bits per second) as of April 2000. The introduction of GPRS may improve the situation slightly by the end of 2000.
- *Lack of graphics* – Or at least, very limited support for them. Icons and graphics can go a long way towards helping the user in complicated situations.
- *Limited deck size* – A deck can contain only a limited amount of information.

3.4 Research Study

There are several techniques and methods used to collect information about the system, for instance :

- conducting interviews
- using questionnaires
- examining existing documents
- observing the WAP web search engine environment

These techniques will help to reveals the processes, data requirements and data flows, as well as input to and output from the system. It also will help to gain knowledge of the functions and the data requirements.

3.4.1 Interviews Result

Interview 1

An informal interview was conducted with a student of FCSIT. As the subject was quite vague, it was agreed that the project needed to focus on a specific target group. The interview findings were the student did owned a mobile phone but without WAP. The student claimed that WAP is not a necessity for her and she only used the mobile phone to receive incoming and outgoing calls and messages (SMS – Short Message service). Furthermore, the SMS cost less than sending email through WAP service. As for her opinion, she said that the WAP phone have a bright future and will become a necessity one day like the mobile phone, where not long time ago, mobile phone is owned only by rich people, business man and in just a small amount of people.

Conclusion : There is a very small percentage of student that have the WAP service, making the WAP web search engine system for the FCSIT is less important and not that essential.

Interview 2

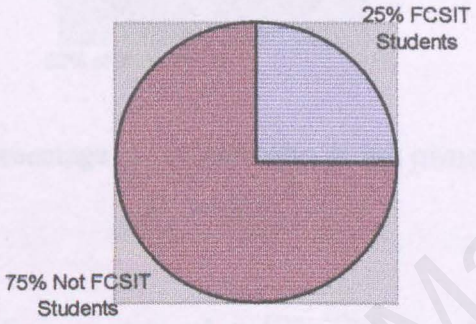
The second interview were also conducted with a student of FCSIT. This student claimed that the WAP search system is quite useful though it is something new and very rarely used. This student has a Palm held which included with WAP service. He claimed that sometimes he needs to know some information about the FCSIT especially the lecturer's email. Sometimes when he is going somewhere else or doing something else, but at the same time he needs to email his lecturer whenever he got problems with his studies, this is when the WAP search engine play its role as a useful system. With the WAP search engine, he would be able to check the lecturer's email wherever or whenever he wants to. Moreover, with the WAP search engine, he would not be bounded by location to find any information especially regarding his studies.

Conclusion : The development of the WAP search system may not be in high demand but there is a little amount of people who still need the existing of the system.

3.4.2 Questionnaires Result

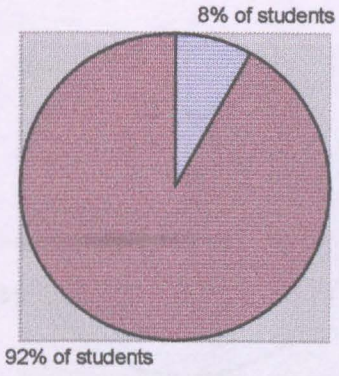
There are 50 questionnaire forms distributed among the residents of UM (for examples : working staffs, students in UM) and most of the questionnaire forms were distributed among the students of FCSIT. The results indicated that more non-

computer related students had mobile phones/PDAs than the students of FCSIT. This is due to larger amount of FCSIT students were focused on in answering the questionnaires. (as shown in Pie Chart 3.0) [Appendix – Question 3]



Pie chart 3.0 : Percentage of FCSIT students and UM students who owned mobile phones/PDAs.

The pie chart 3.1 is showing the percentage of students who have a WAP mobile phone or PDAs are less than students who do not have WAP services through their wireless devices. Among the 50 students, the pie chart indicates that only 8% of students who have a WAP devices while the rest do not have devices with WAP capabilities. [Appendix – Question 5]

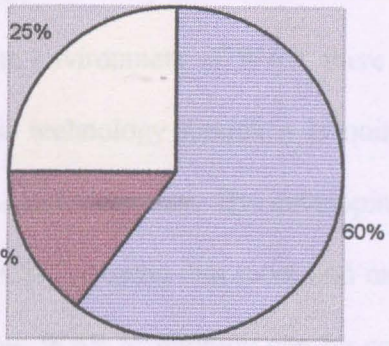


Pie chart 3.1 : The percentage of students who do not owned or owned a WAP device.

Pie chart 3.2 is showing the percentage of students who owned a WAP mobile phones or PDAs, used the devices in variety of tasks. Most of them use the facility to :

[Appendix – Question 1 : Section A]

- E-mail (60 %)
- Internet (15 %)
- Browsing (25%)



Pie chart 3.2 : The percentage of the usage.

Conclusion : More questionnaire forms were distributed to FCSIT students than other UM students because the WAP web search engine system is focusing on FCSIT. That means more information related to FCSIT. Therefore the maximum usage of the system would be targeted to the lecturer of FCSIT, students of FCSIT or other people who would like to seek information regarding FCSIT.

3.4.3 Examining existing documents.

As mentioned before, there are a lot of existing system that can be learn from. Every system has their own objectives and different styles in coding, in interface and so on. Many of the existing WAP search engine system have too many decorative and irrelevant WAP web page. And this is unappropriate and a waste of time. Hence, in this project, the main objectives of the WAP web search engine is developing a simple interface but interactive with relevant WAP pages and focusing on information about FCSIT.

3.4.4 Observation

Within this study it was thought necessary to use observation to the WAP web search environment. By observing the environment of WAP, there are not many students or people are using the wireless technology though it is quite a facility. But still, the technology is growing each and everyday. By developing the WAP web search engine system, focusing on FCSIT, hoping that more and more student/people will be aware of, and realized on how WAP technology can be so beneficial. Though there are only a few amount of students or users who can use the WAP search system, by hope, the amount will be increasing in the future.

CHAPTER 4 : SYSTEM DESIGN

4.0 Introduction

Design is the creative process of transforming the problem into a solution. The description of a solution is also called design. Design is a method that translates user requirements into a product or finished system. All of the information gathered during the system analysis phase will be converted into smaller modules until a system is being developed.

System design is concerned with how the final system will work. It is viewed as a process that represents data structure, program structure, interface properties and procedural information. It includes processes such as below :

- Process Design
- Database Design
- Interface Design
- Network Design

4.1 Process Design

Process design describes on how modules or functions of an information system are structured (organized) and how they will interact with one another to perform the various system tasks.

Processes in the WAP web search system are depicted using Data Flow Diagrams. Process design will be visualized by using DFD because it is a graphical technique that will display the data flow in the system. As a transformer of data, the diagram shows the data flow into the system, how they are transformed and how they leave the system. The emphasis is on the flow of the data, not on the flow of control. It will also be able to view the changing process or the converting process that is being implemented to the data once the data goes into the system, through the system and out if the system. The hierarchy is expressed by layering, so that different details are shown in different layers. It can be divided into several levels that can visualize the ascending data flow and functional information.

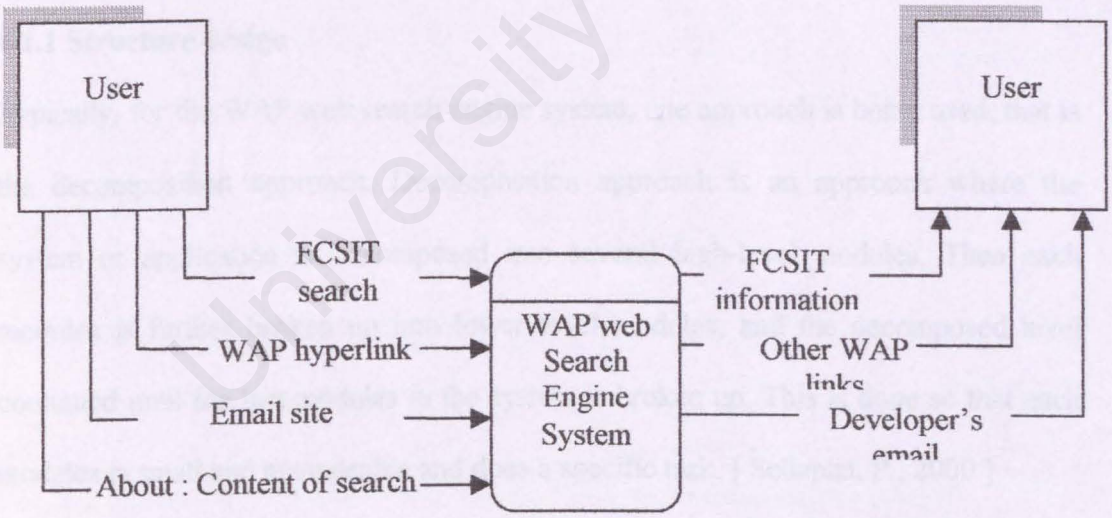


Figure 4.0 : Context Diagram

The figure 4.0 is showing on how the user requests data or information on the WAP web search system. The user will request for data/information about FCSIT by browsing to start searching. Other than that, the user may request for other WAP search engine that is linked to the WAP web search page to browse other information. The user also get to give comments about the WAP search site or get to interact with the WAP site developer by email. If user wants to know what data/information can be retrieve from the database, the user can click on the 'Search content' link. The link will show the content of the searching lists.

Finally, after all the requested information have been processed and retrieved from the database, all the information needed will be displayed back to the user.

4.1.1 Structure design

Typically, for the WAP web search engine system, one approach is being used, that is the decomposition approach. Decomposition approach is an approach where the system or application is decomposed into several high-level modules. Then each modules is further broken up into lower level modules, and the decomposed level continued until the last modules in the system is broken up. This is done so that each modules is small and manageable and does a specific task. [Sellapan, P., 2000]

To show the hierarchy of the modules of the WAP web search system, a structure chart is being used. The higher level modules describe higher level functionality while the lower level modules describe the detailed functionality. The higher level

modules invoke or call the lower level modules to perform needed tasks. It is also called as a top-down approach. [Sellapan, P., 2000]

The figure 4.1 and figure 4.2 are showing the structure charts used to show the workflow of the WAP web search engine system. According to the chart, the WAP search system has been divided into several components depending on its functionality. Components on the higher level will represent functions that are available in the main interface display followed by the rest of the components.

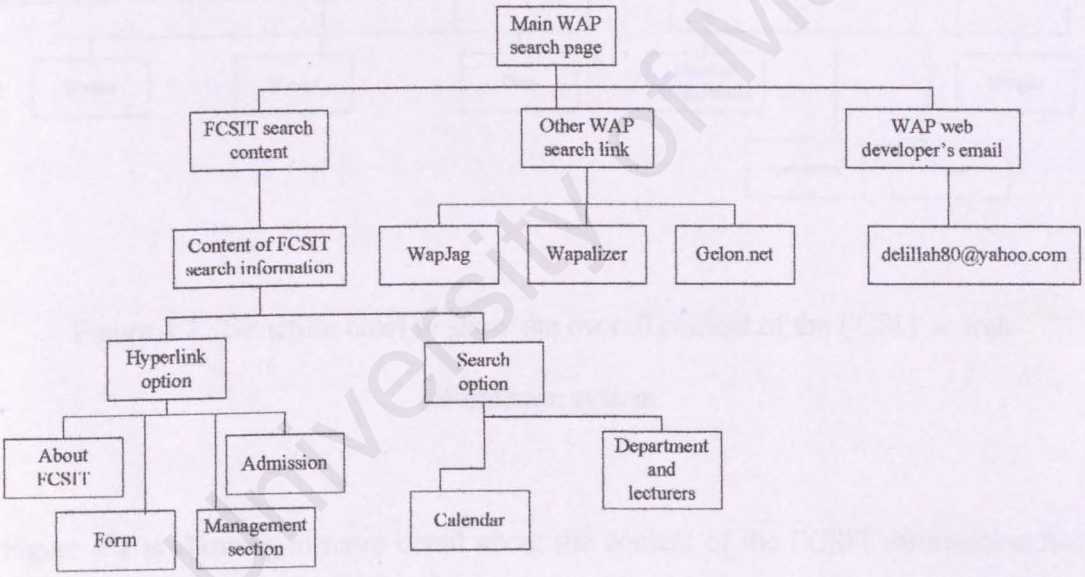


Figure 4.1 : Structure Chart for the WAP web search engine system.

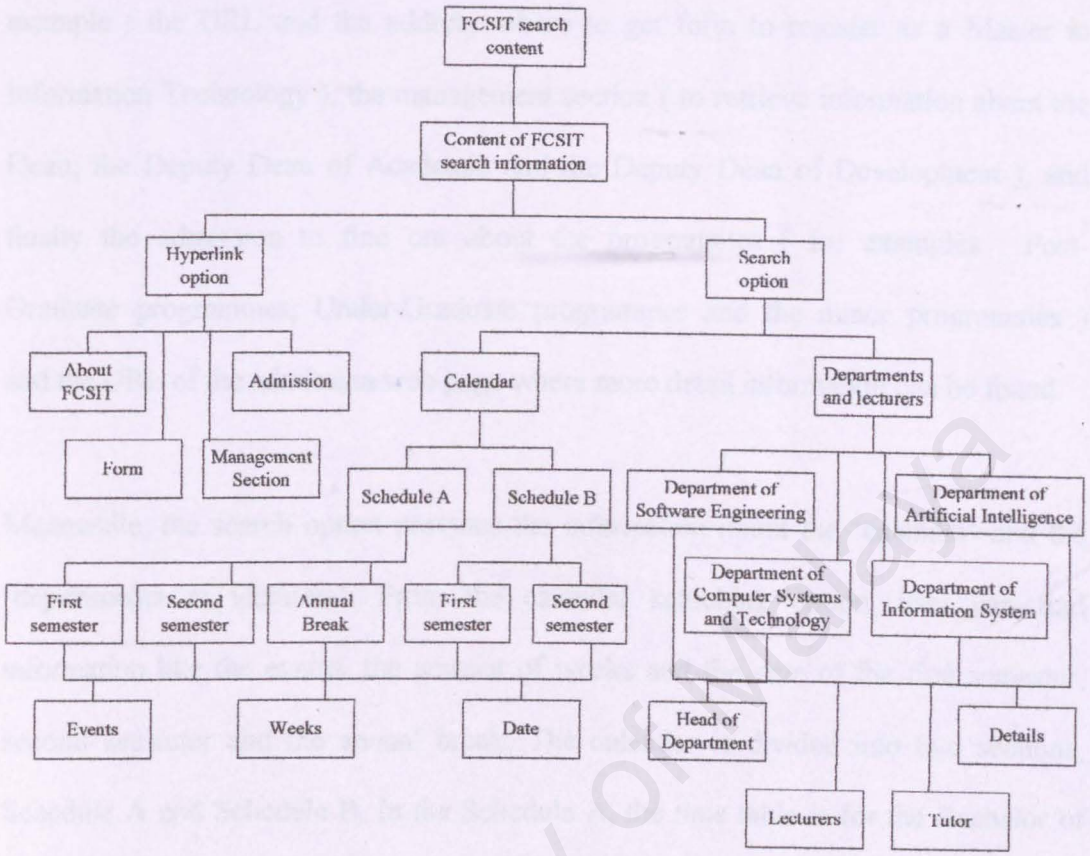


Figure 4.2 : Structure chart to show the overall content of the FCSIT search information system.

Figure 4.2 is showing in more detail about the content of the FCSIT information that can be retrieved from the system. When the user clicks on the 'Search Content', it will link to a page that contained list of information about the FCSIT. There are two options in the content page. User can choose whether she/he wants to retrieve information by hyperlink or by search. The hyperlink option provides information about the FCSIT (for examples : the location address of FCSIT, the email, telephone number, fax number and the URLs of the FCSIT web and WAP page), forms (for

example : the URL and the address where to get form to register as a Master in Information Technology), the management section (to retrieve information about the Dean, the Deputy Dean of Academic and the Deputy Dean of Development), and finally the admission to find out about the programmes (for examples : Post-Graduate programmes, Under-Graduate programmes and the minor programmes) and the URL of the admission web page where more detail information can be found.

Meanwhile, the search option provides the information about the 'calendar' and the 'departments & lecturers'. From the calendar searching option, user can find information like the events, the amount of weeks and the date of the first semester, second semester and the annual break. The calendar is divided into two sections, Schedule A and Schedule B. In the Schedule A, the time table is for the Bachelor of Computer Science (First and final level), the Bachelor of Information Technology (First and final level), the Master of Software Engineering, the Master of Library & Information Science, the Master of Computer Science and the Master of Information Technology students. While in Schedule B, the time table is limited to the Master of Computer Science (Mid level) and the Master of Information Technology (Mid level) students.

4.1.2 Unified Modeling Language (UML)

The UML has been designed to help the participants in software development efforts build models that will enable the team to visualize the system, specify the structure and behavior of that system, construct the system and document the decisions made along the way. There are several techniques and notations used in UML, for instance,

Use Case, Class diagram, Collaboration diagram, Sequence diagram and State diagram. The examples of techniques that are used in the system, are shown as below : [Scott, K., 2001]

a) Sequence diagram (in Figure 4.3)

b) State diagram (in Figure 4.4)

In this project, the sequence diagram is used to represent model of interactions between objects in the main page. The sequence diagram is shown in the figure 4.3.

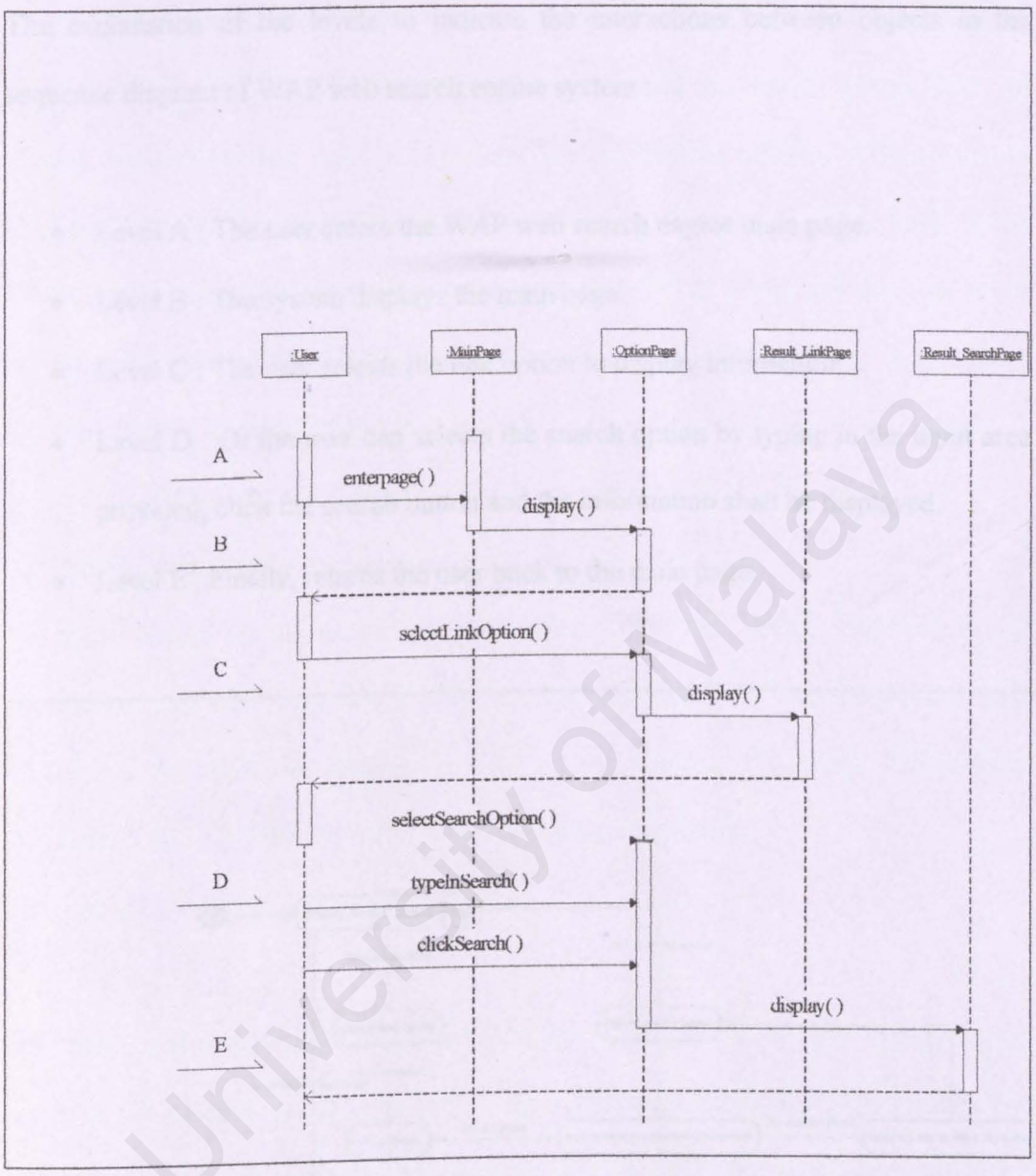


Figure 4.3 : The Sequence Diagram of WAP web search engine.

The explanation of the levels to indicate the interactions between objects in the sequence diagram of WAP web search engine system :

- Level A : The user enters the WAP web search engine main page.
- Level B : The system displays the main page.
- Level C : The user selects the link option to display information.
- Level D : Or the user can selects the search option by typing in the input area provided, click the search button and the information shall be displayed.
- Level E : Finally, returns the user back to the main page.

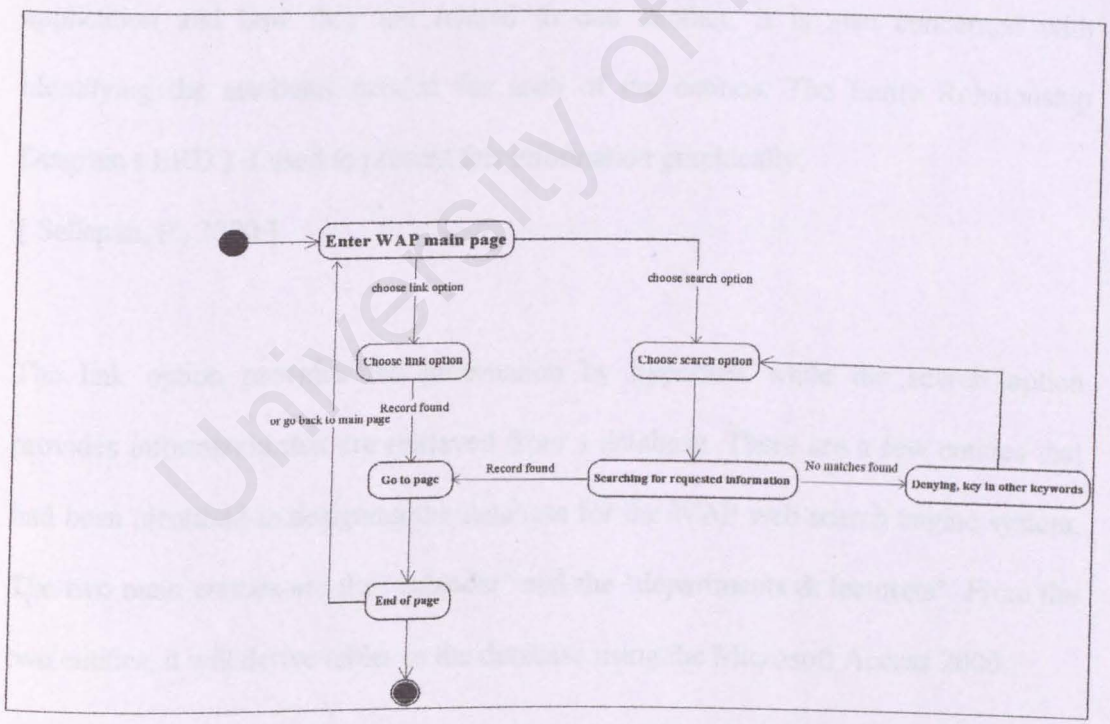


Figure 4.4 : The example of a State Diagram for the WAP search system.

Figure 4.4 is indicating the steps of the WAP search system. There are two options available from the WAP main page, the link option and the search option. User can choose between the two options to retrieve the information needed. If the requested information is not found using the search option, it will lead the user back to the searching page. If the record of information is found, then it will lead the user to the desired page. At the end of the page, the user can choose whether wants to go back to the main page or exit from the search system.

4.2 Database Design

Database design is concerned with identifying the task entities relevant to the application and how they are related to one another. It is also concerned with identifying the attributes needed for each of the entities. The Entity Relationship Diagram (ERD) is used to present this information graphically.

[Sellapan, P., 2000]

The link option provides the information by hyperlink while the search option provides information that are retrieved from a database. There are a few entities that had been identified in designing the database for the WAP web search engine system. The two main entities are the 'calendar' and the 'departments & lecturers'. From the two entities, it will derive tables in the database using the Microsoft Access 2000.

List of attributes for each entity showing the relationship that has been created using keys:

Calendar

Main entity : Calendar (EventA_ID, EventB_ID, Agenda)

Minor entities : Schedule A

First Semester (EventA_ID, Events, Amount_of_weeks, Date)

Second Semester (EventA_ID, Events, Amount_of_weeks, Date)

Annual Break (EventA_ID, Events, Amount_of_weeks, Date)

Minor entities : Schedule B

First Semester (EventB_ID, Events, Amount of weeks, Date)

Second Semester (EventB_ID, Events, Amount of weeks, Date)

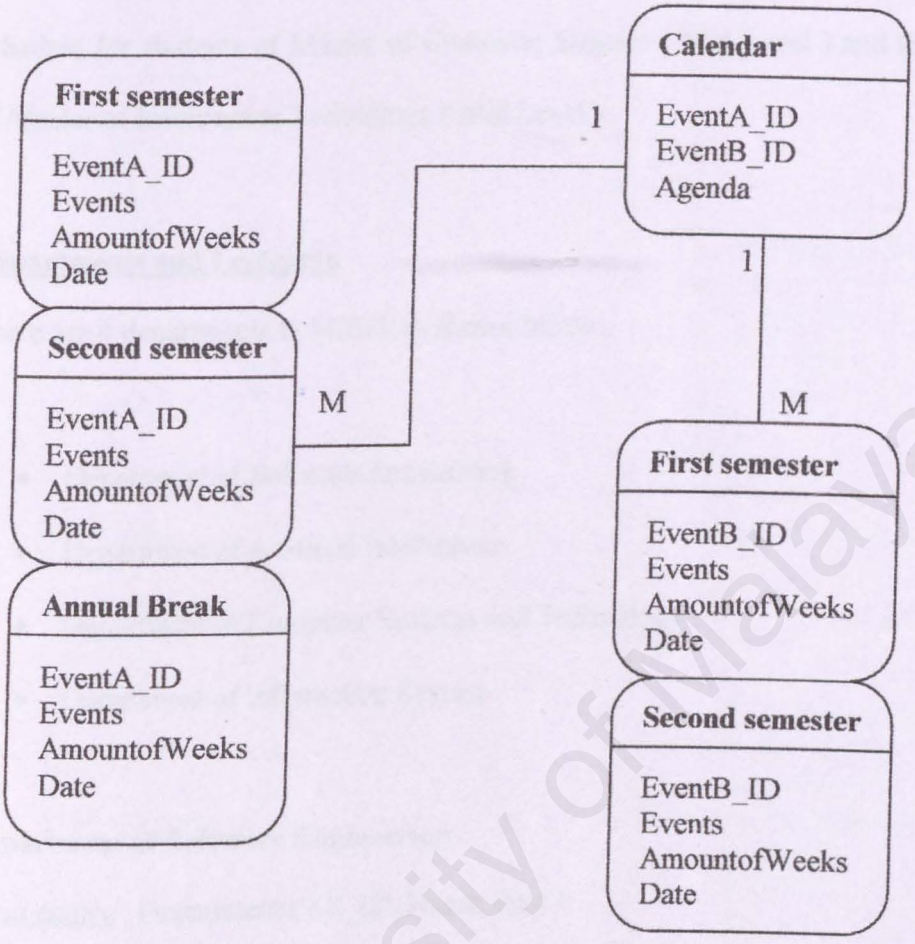


Figure 4.5 : The Entity Relationship diagram for Calendar.

The figure 4.5 is showing the database relationship for calendar. There are 2 sections, the first section is describe in Event A while section B is describe in Event B. The section A is the semester schedule for the students of Bachelor of Computer Science (First and Final Level), Bachelor of Information Technology (First and Final Level), Master of Software Engineering, Master of Library & Information Science and the students of Master of Information Technology. The section B is the semester

schedule for students of Master of Computer Science (Mid Level) and the students of Master of Information Technology (Mid Level).

Departments and Lecturers

There are 4 departments in FCSIT as shown below :

- Department of Software Engineering
- Department of Artificial Intelligence
- Department of Computer Systems and Technology
- Department of Information System

Department of Software Engineering :

Main entitry : Department (SE_ID, Name, Post)

Minor entities :

Lecturer (SE_ID, Name, Email)

Tutor (SE_ID, Name, Email)

Other entity : Details_of_SE (Address, Telephone_number, Fax_number, Email)

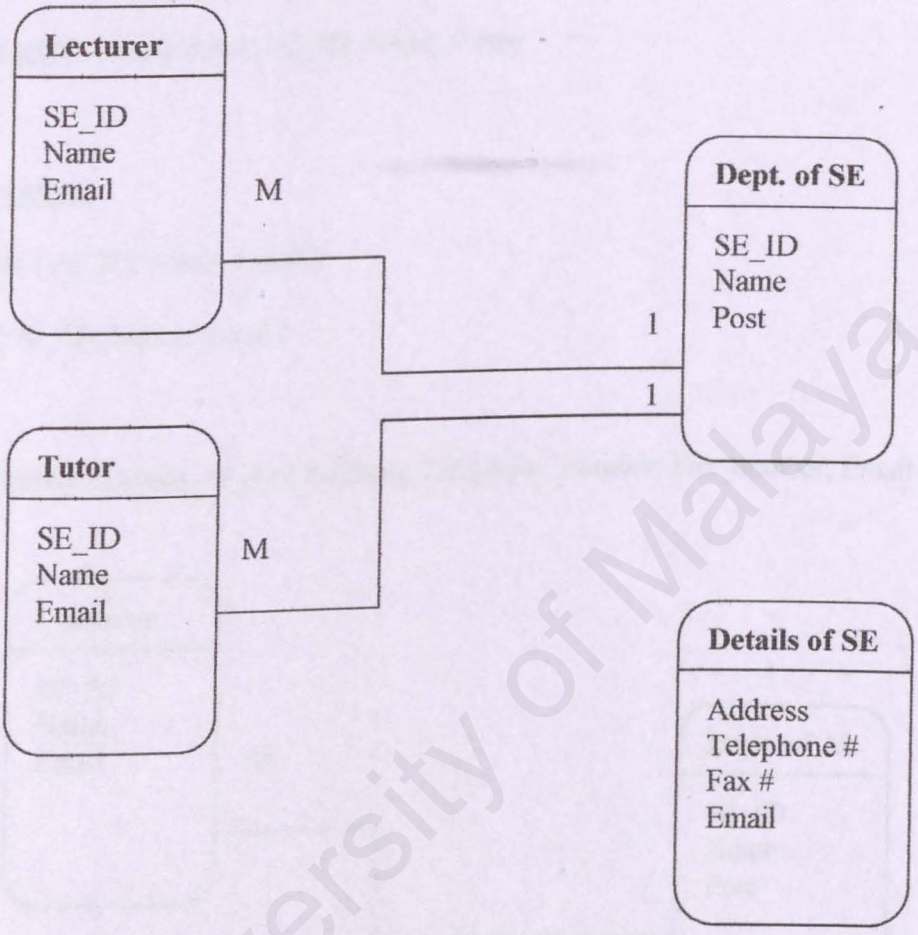


Figure 4.6 : The Entity Relationship for the department of Software Engineering.

Department of Artificial Intelligence :

Main entitry : Department (AI_ID, Name, Post)

Minor entities :

Lecturer (AI_ID, Name, Email)

Tutor (AI_ID, Name, Email)

Other entity : Details_of_AI (Address, Telephone_number, Fax_number, Email)

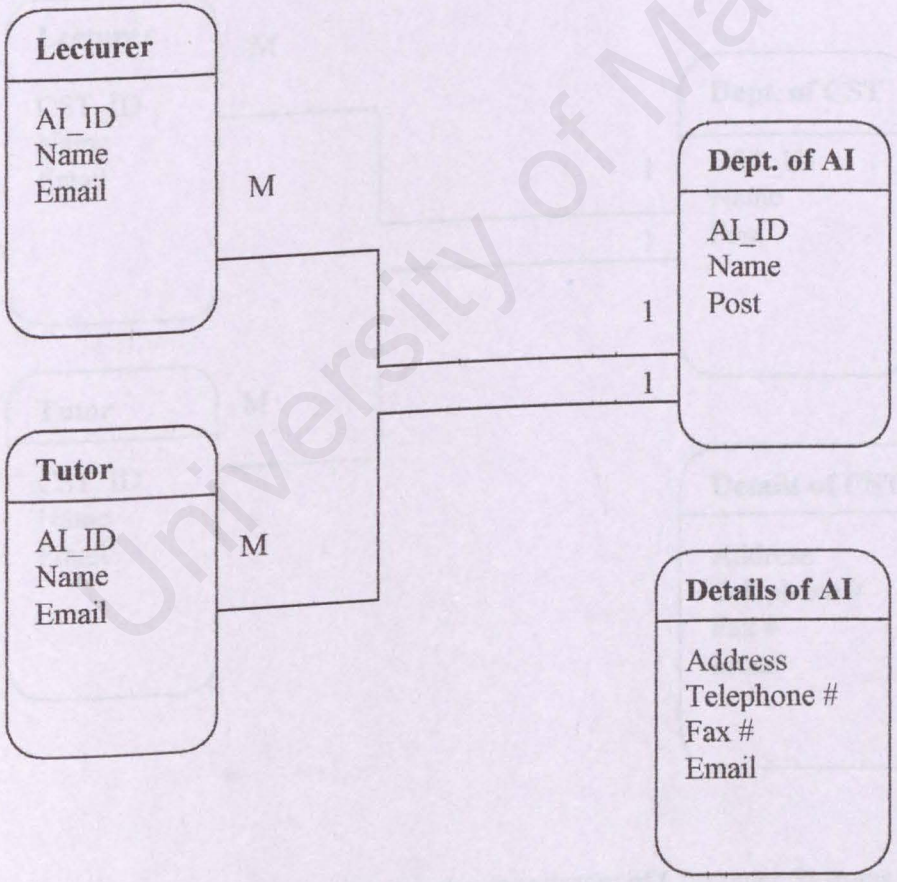


Figure 4.7 : The Entity Relationship diagram for the department of Artificial Intelligence.

Department of Computer Systems and Technology :

Main entitry : Department (CST_ID, Name, Post)

Minor entities :

Lecturer (CST_ID, Name, Email)

Tutor (CST_ID, Name, Email)

Other entity : Details_of_CST (Address, Telephone_number, Fax_number, Email)

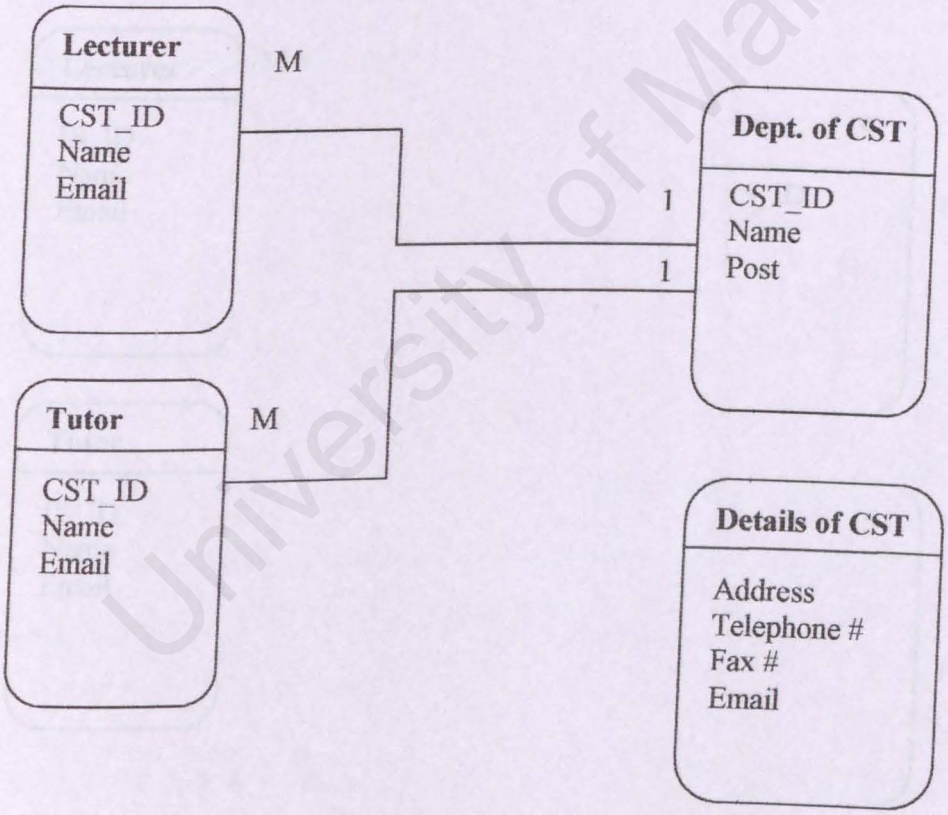


Figure 4.8 : The Entity Relationship for the department of Computer Systems and Technology.

Department of Information System :

Main entitry : Department (IS_ID, Name, Post)

Minor entities :

Lecturer (IS_ID, Name, Email)

Tutor (IS_ID, Name, Email)

Other entity : Details_of_IS (Address, Telephone_number, Fax_number, Email)

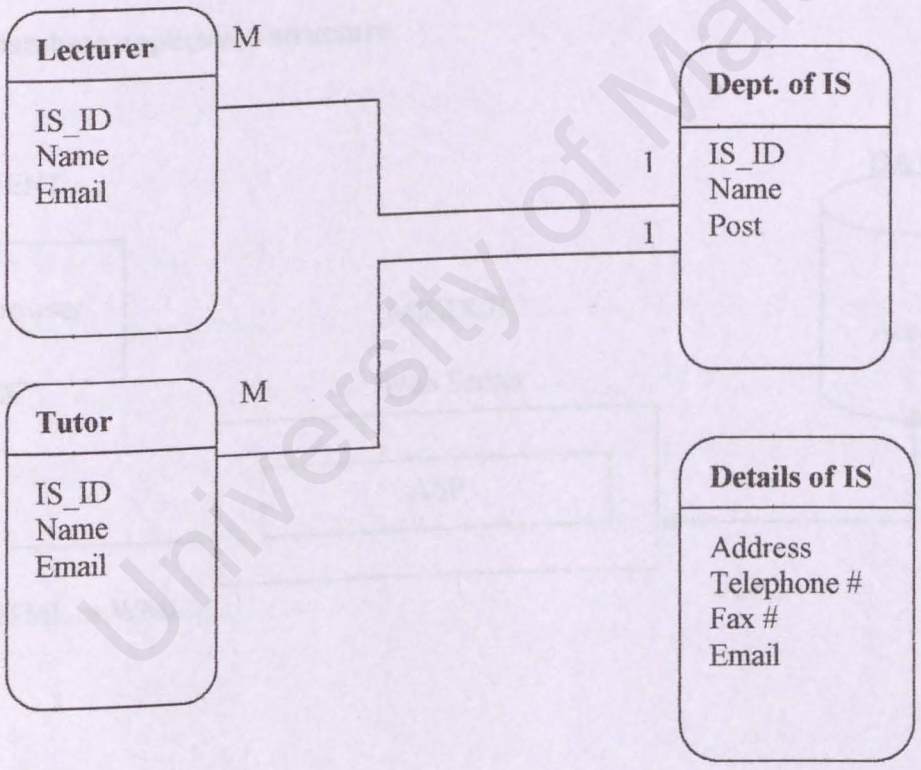


Figure 4.9 : The Entity Relationship diagram for the department of Information System.

The figure 4.6, 4.7, 4.8 and 4.9 are showing the database relationship for the departments and lecturers for the department of Software Engineering, Artificial Intelligence, Computer Systems and Technology and Information System, respectively. There 4 entities within the database, lecturer, tutor, details of the departments and the departments.

The database tables for WAP web search engine system will be using Microsoft Access 2000. All data are stored in tables that will view different entities.

4.2.1 Database application structure

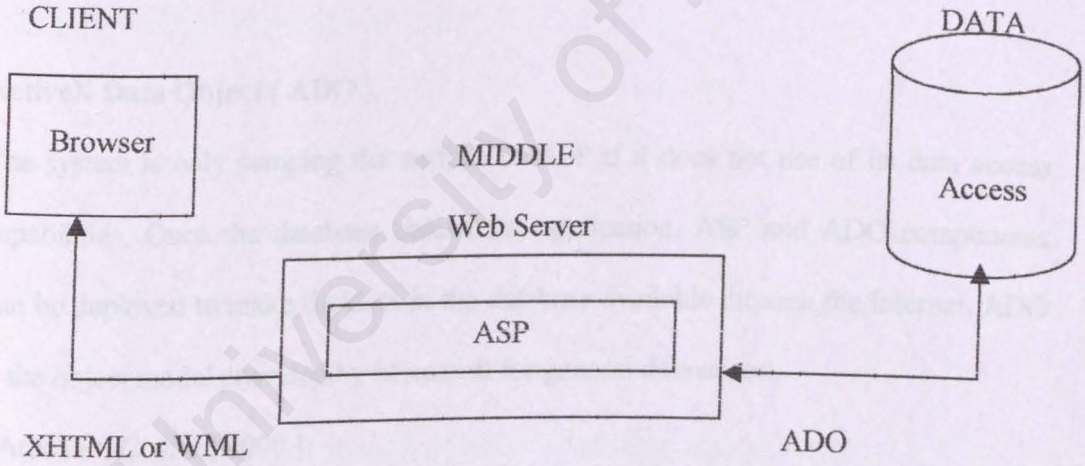


Figure 4.10 : Three-tier architecture of the database application structure.

Figure 4.10 is depicted the architecture of the database. The client renders the user interface in XHTML or WML. The client communicates directly with the middle tier's business logic (i.e. the set of instructions for handling client requests and for interaction with the data tier). In this project, the middle tier is manipulated using Active Server Pages (ASP). ASP documents access the data tier using ActiveX Data Objects (ADO). ADO provides a uniform way for an ASP document to connect with a variety of databases in an application-independent manner without having to use database-specific features. The WAP search engine system is using a Microsoft Access database, which contains information of FCSIT. This database is manipulated using the Structured Query Language (SQL). SQL allows applications to query and manipulate data. [Deitel, H. M. *et al*, 2001]

ActiveX Data Object (ADO)

The system is only scraping the surface of ASP if it does not use of its data access capabilities. Once the database behind the application, ASP and ADO components can be deployed to make the data in the database available through the Internet. ADO is the object model provided by Microsoft for general data access.

[Arechart, C. *et al*, 2000]

4.3 Interface Design

The interface design is concerned with how the users will use the functionalities provided in the system. In the WAP web search engine system, the usability is the main concern in the interface design. Users must find the interface is simple and easy to use, easy to navigate, is consistent and minimize the ambiguity.

[Sellapan, P., 2000]

User interface design is an important aspect in developing software. This is because an interesting and a simple user interface design will inspire and motivate a user to use the system.

Objectives of building a user interface:

- *Effectiveness of using user interface*

  This can be accomplish by designing an interface that meets the user requirements and the simplicity if the interface to avoid confusion.

- *Interface reliability*

  Interface accuracy in performing data capturing without errors.

- *User judgement*

  User interface developed must meets user requirements and respose given by the system must be accurate and meets the user's request.

- *Productivity*

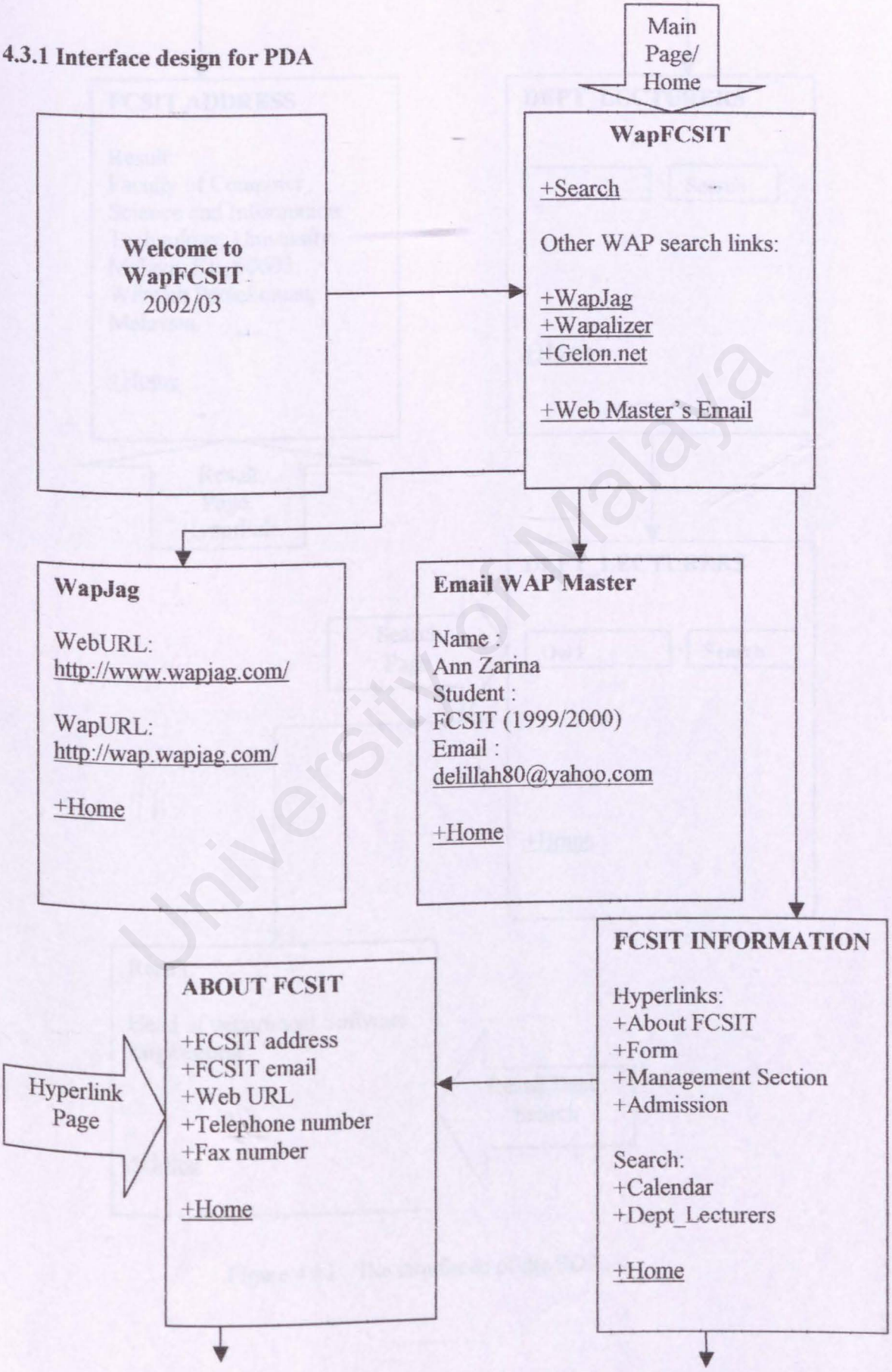
  This can be measured by developing a good user interface that reduce building cost and response time.

Interface design (in figure 4.4) will visualize the display that will be used as an interaction medium between the user and the system. There are several qualities of the typical user point to a single important truth about wireless application design : Keep it simple and intuitive.

1. The application should be intuitive so that it is easy to use without any prior knowledege.
2. Consistency betweeen pages to avoid confusion for users.
3. Control measures such as input area box for searching task is used to accelerate data recording process.
4. Suitable type of fonts are used so that the interface would not look too complex and it would be more organized and easy to understand.
5. Appropriate font size due to small screen devices.
6. The text and the input box must be at the user eye-level so it would be easier for the user to look, navigate or find information in the WAP web search engine page.
7. Not much details in one deck (page) due to small screen WAP devices and with less details on the page, the user would be less confused.
8. Avoids complexity because as the application complexity increases, the demands it places on users' patience, attention and time likewise increase.

Complex applications will not be used if similar functionality can be found in a simpler application.

4.3.1 Interface design for PDA



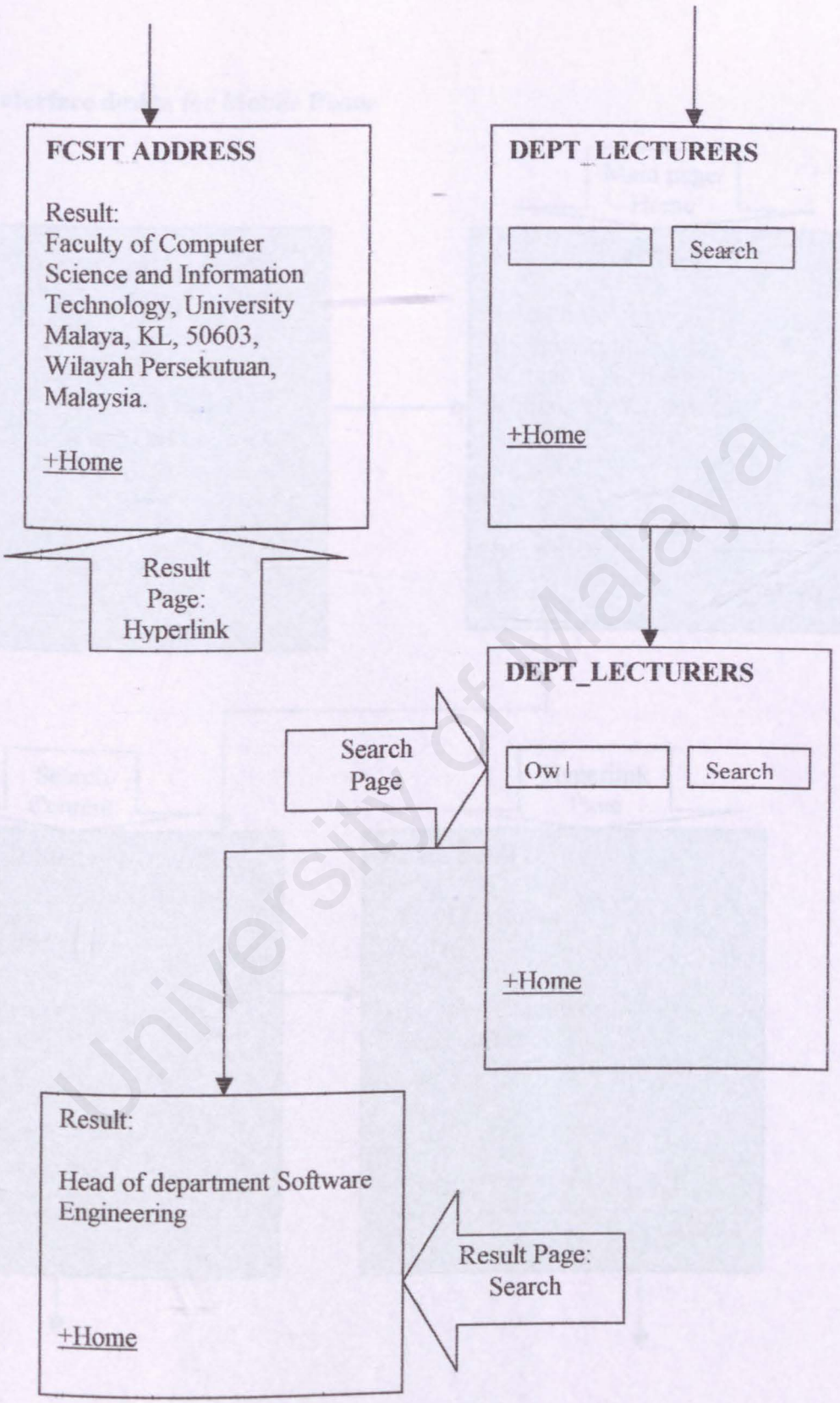
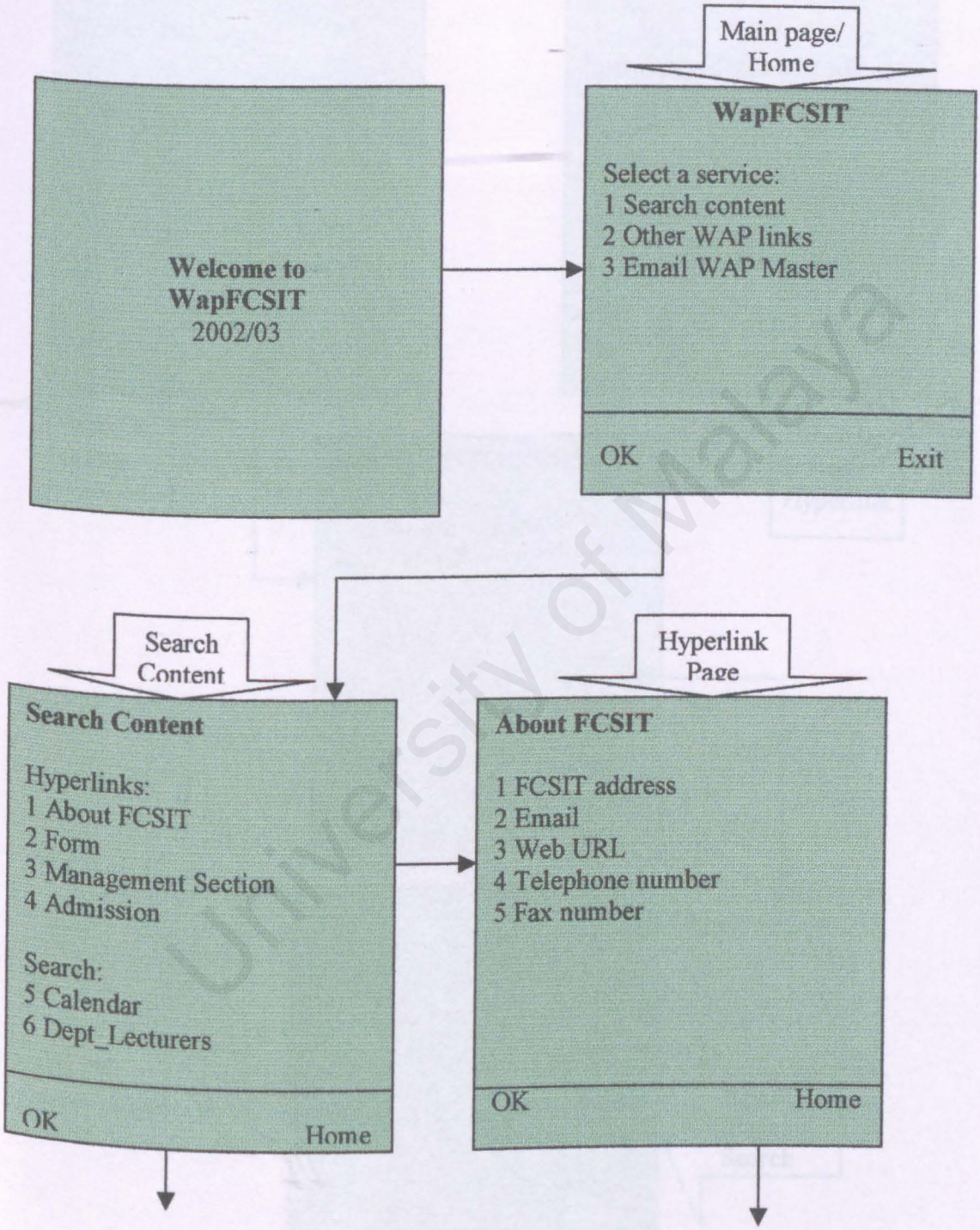


Figure 4.11 : The interfaces of the PDA.

4.3.2 Interface design for Mobile Phone



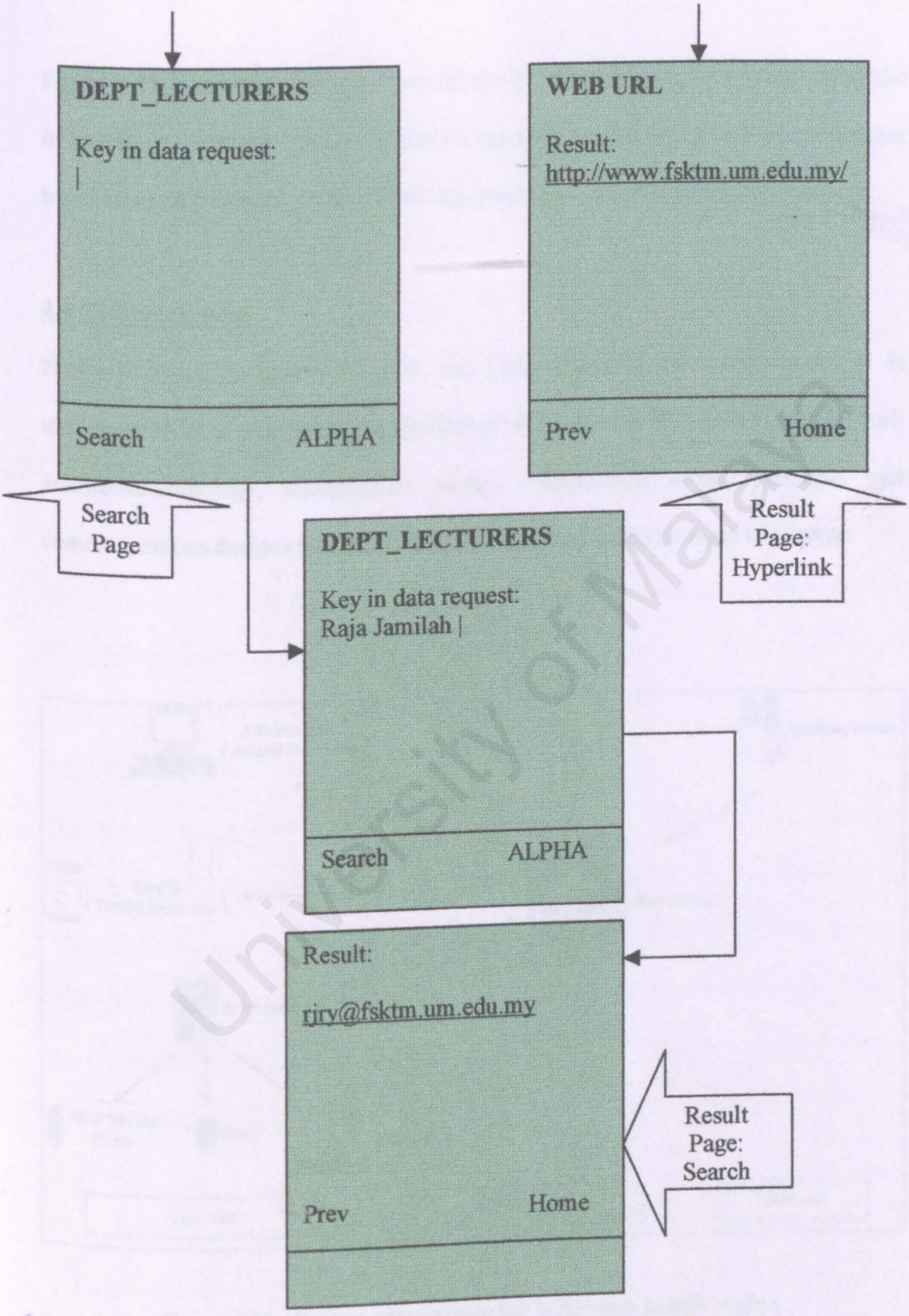


Figure 4.12 : The interfaces of the Mobile Phone.

Figure 4.11 is showing the interfaces of the PDA and figure 4.12 is depicting the interfaces of the Mobile phone. And as for the font size, the head, titles and other text have disparate font sizes to show their differential in delivering the information.

4.4 Network Design

Network design is concerned with the architecture of the system when it is implemented in a geographically distributed environment. It describes the network architecture/topology, transmission media, transmission mode, protocols and communications devices that are used to transmit data from one node to another.

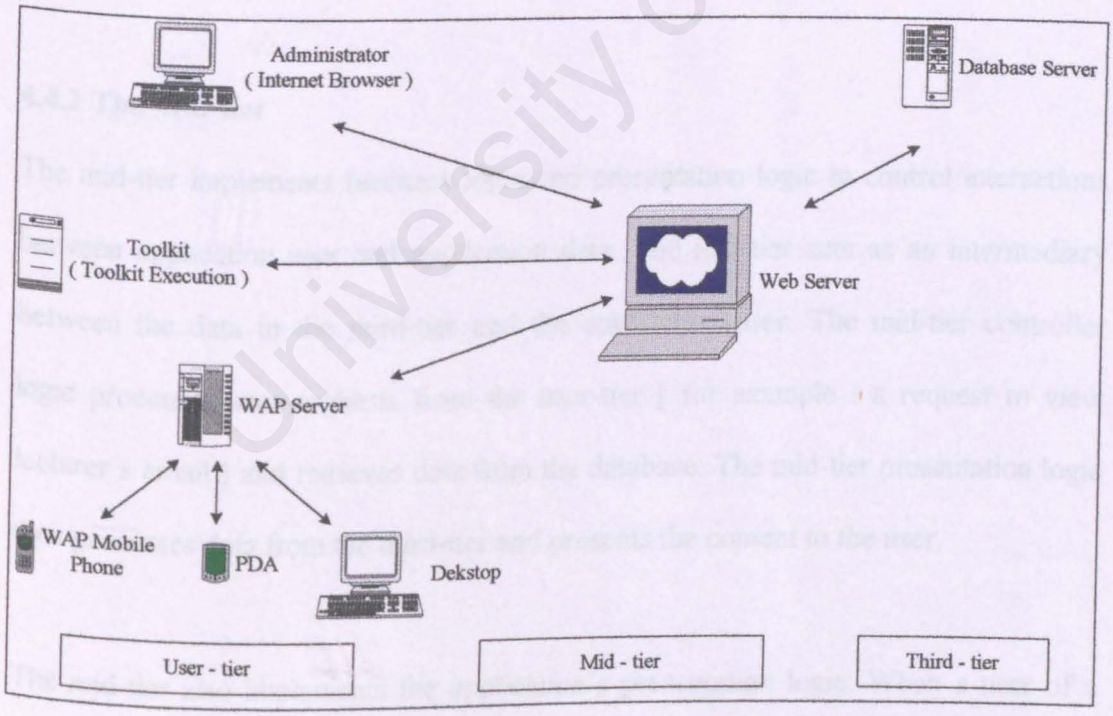


Figure 4.13 : System architecture for WAP web search engine.

Figure 4.13 presents the WAP web search engine network design. A web server is a multi-tier application. There are three-tier application basically, the user-tier (or the client-tier), the mid-tier (or the middle-tier) and the third-tier (or the information-tier). [Deitel, H. M. *et al*, 2001]

4.4.1 The User-tier

The user-tier is the application's user interface. Users interact directly with the WAP web search application through the user interface as shown in the figure 4.11 and figure 4.12. The user interacts with the mid-tier to make requests and to retrieve data from the third-tier (the information-tier). The user then displays the data retrieved from the mid-tier to the user.

4.4.2 The Mid-tier

The mid-tier implements business logic and presentation logic to control interactions between application user and application data. The mid-tier acts as an intermediary between the data in the third-tier and the application user. The mid-tier controller logic processes user requests from the user-tier [for example : a request to view lecturer's email] and retrieves data from the database. The mid-tier presentation logic then processes data from the third-tier and presents the content to the user.

The mid-tier also implements the application's presentation logic. When a user of a WAP-enabled device (for examples as shown in figure 4.13, mobile phone, PDA, desktop) requests information from the WAP web search system (that is connected to the Internet), the device sends the request to a WAP gateway or WAP server. A

WAP server serve as links between wireless devices and the Internet. WAP server are designed to convert WAP content from WML to HTTP, which is the standard protocol used to transfer and view information in Web transactions. The WAP server communicates with the Web server. The Web server processes the user request by searching through existing databases. The web server then transmits the requested information back to WAP server , using HTTP. The WAP server translates the information into WML and sends it to the user's wireless device for use.

4.4.3 The Third-tier

Finally, the third-tier or the information-tier maintains data for the application. The third-tier typically stores data in a relational database management system (RDBMS).

4.5 Conclusion

The system design for WAP web search engine processes such as, process design, database design, interface design and network design, have been eloborated to solve the problem inherent in the system and to deal with the new requirements. This chapter is concerned with synthesizing all the parts together into a viable, workable system.

CHAPTER 5 : IMPLEMENTATION

5.0 Introduction

System implementation is a development of a new system and the delivery of the system towards production in daily operation. The main reason for system implementation is the technical design from the system design. Information system that develops system implementation includes data, process and user interface based on the perspective of the system developer.

System implementation can be divided into four main phase that is:-

i) Develop and Test Network and Database

ii) Testing and Developing Program

iii) Installation and New System Testing

iv) Delivering the New System for Operation

5.1 The System Implementation Phases

5.1.1 Building and Testing Network and Database

If a new application requests for a new network or a new database, it will first be implemented before developing and installing the computer program. The database used for the WAP Web Search Engine System is Microsoft Access 2000.

The main input for this phase is the subset from the real technical design that visualize the network or the database design. The main product is a network and

database that has not yet been populated. The structure of the database has been implemented but data has not yet been inserted in the structure of the database. Program developer will finally write a program to populate and enchance the database.

5.1.2 Building and Testing the Program

This phase is also known as the development phase. Program developing and testing usually takes a very long time and it is a very tiring phase in developing a system. Program developer has to work from the specification that has been developed and filtered through the prephase and preactivity in the Waterfall Model. If the specification of the system is not clear, not completed, not accurate or ruined, the development phase will be more complicated and takes a longer time.

The main input to this phase is the subset from the technical design statement that contains the specification of the program. If the new or modified network and database will be used, the database that has been implemented but has not yet been populated is the input from the implementation phase that has been done before. The product of this phase is a computer program that has not yet been installed but has been completely tested and debugged to be used for production.

5.1.3 Installing and Testing the New System

The next phase in system implementation is to install and test the new system using the simulator. The main input to this phase is a subset of the technical design

statement that gives the specification on how the program has been developed and tested. Files and database will be piled up in the integrated system.

5.1.4 Delivering the New System for Operation

The final phase in implementation is to deliver the new system for operation. By providing a various system manuals helps users in using the new system.

5.2 Developing WAP Web Search Engine System (WapFCSIT)

The phase that needs a very long period to be completed is the development phase of the WAP Web Search Engine itself. It involves interpretation and the implementation of all gathered requirements including system technical design into program codes. The combination of technical and physical design into program codes had been done using two main languages, WML and ASP. To view the system, the UP.Simulator version 4.1 will be used.

5.2.1 Coding Phase

Coding phase is the phase where all the result from the analysis phase and the design phase is being transform into a real application system. This phase also requires quite a long period of time to be completed because WAP Web Search System is being develop using high level programming language. The main software that has been used to simulate WAP Web Search System is UP.Simulator version 4.1. The WML and ASP coding are using the Notepad as the programming languages editor.

Besides considering the output from the phase before, other limitations factors for developing the system must also be considered. Several limitations factors that has to be considered are:

i. Limited time and energy for this phase

ii. Development cost factor

iii. Application system size factor due to limited information can be displayed on the screen and limited source codes can fit in one card.

5.3 Development Tools Implementation

The WAP Web Search Engine system is developed using the UP.Simulator version 4.1 as the main simulator, Nokia Mobile Internet Toolkit 3.1 as an alternative simulator and notepad as the coding editor, running under a web server (IIS). UP.Simulator 4.1 is used as the main tool instead of Nokia WAP Toolkit 2.0 as proposed earlier due to the below reasons :

- Features enhancement/upgraded version of the tools. For examples, Nokia WAP Toolkit 2.0 has been upgraded to Nokia Mobile Internet Toolkit 3.1.
- Tools that provide better performance are used instead of the proposed tools.
- UP.Simulator is easy-to-use, is used widely and many examples in the reference books are using UP.Simulator as the tool compared to Nokia Mobile Internet Toolkit. However, to test the application in a different environment, the Nokia Mobile Internet Toolkit is used.

5.4 Development tools and the setup steps

5.4.1 UP.Simulator 4.1 from Phone.com's UP.SDK

The UP.SDK for Windows is available for free from Phone.com's web site. However, before downloading the SDK, developer must register for a free developer's account. The UP.SDK package contains four components as shown in the table below :-

Table 5.0 : UP.Simulator components

Component	Description
UP.Simulator	Device emulator
Developer documentation	Contains the WML and WMLScript references
Source code of example applications	Sample WAP applications
UP.Link notification library and tools	Tools for sending push messages, and so forth

The UP.Simulator is one of the most robust and easy-to-use emulators, which uses the Phone.com microbrowser, UP.Browser. For examples, UP.Browser is also used in many web-enabled mobile devices :-

- Ericsson R280
- Nokia 6185
- Motorola Accompli 6188
- Siemens SL-45, S35, C35 and M35

For an updated list of phones that use UP.Browser, go to http://developer.phone.com/dev/ts/up/phones.html

[Foo, Soo Mee *et al*, 2001]

The UP.SDK software can be obtained from Phone.com's web site at http://www.phone.com. The download installation file for this version is upsdkW411e.exe. The phone browser window displays the simulated phone interface for many different phones. Figure 5.0 is showing the default phone interface. To emulate real device behavior, the "skin" can be changed to emulate an actual phone. To do so, simply click on the File menu and choose the option, Open Configuration. Then, select the dialog box with a list of available "skins". Highlight the chosen "skin" and click Open button. Figure 5.1 is showing a selection of a skin from the Open Configuration file dialog box.

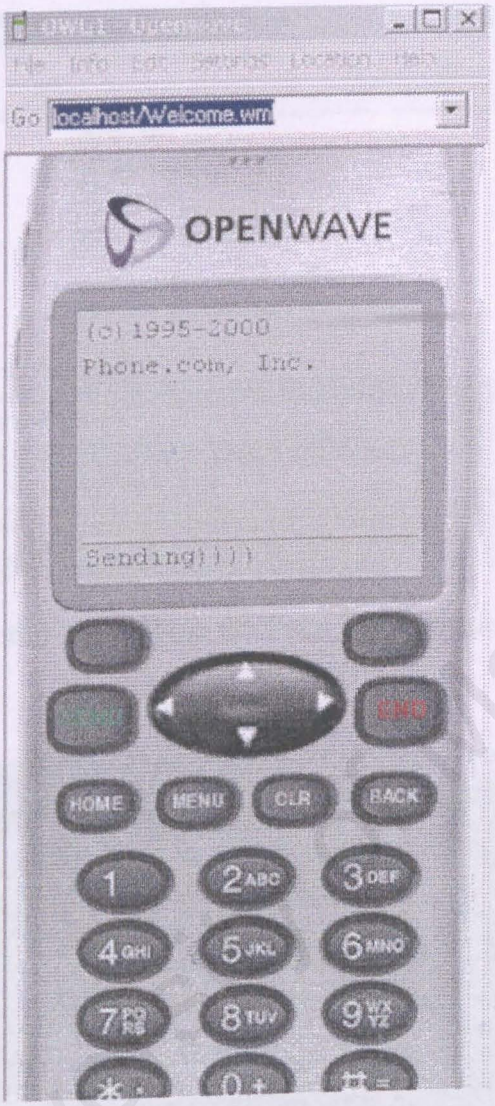


Figure 5.0 : UP.Simulator's phone interface

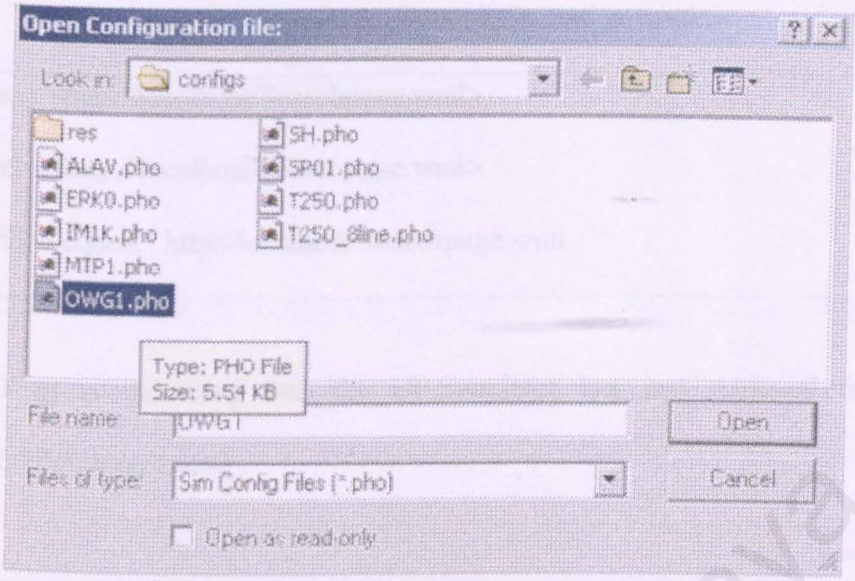


Figure 5.1 : Selecting a skin from the Open Configuration file dialog box

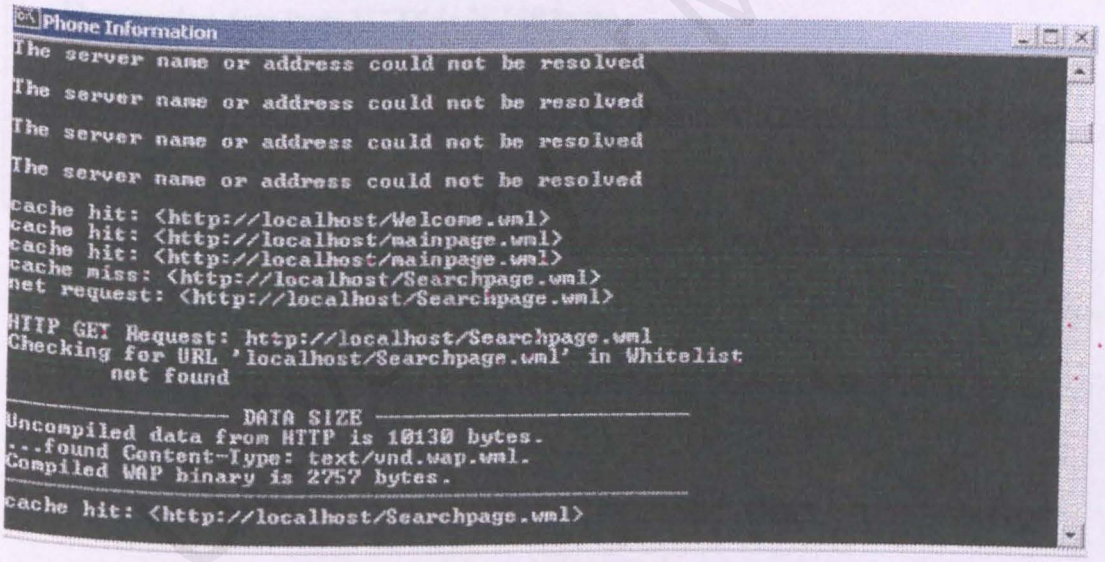


Figure 5.2 : Phone Information window

Figure 5.2 is showing one more important component of the emulator is the Phone Information window, which displays what goes on behind the scenes. It provides useful hints when debugging the application. For example :-

Table 5.1 a) and b) : Phone Information window

cache miss : <http://localhost/Searchpage.wml>
net request : <http://localhost/Searchpage.wml>
HTTP GET Request : http://localhost/Searchpage.wml

Table 5.1 a) is indicating that the UP.Simulator has just retrieved the WML document, Searchpage.wml.

Table 5.1 b)

---------- DATA SIZE ----------
Uncompiled data from HTTP is 10130 bytes.
… found Content-Type : text/vnd.wap.wml.
Compiled WAP binary is 2757 bytes.

Table 5.1 b) is showing the size of the uncompiled http is 10130 bytes. After compiling the WML document into the WAP bytecode, the size becomes 2757 bytes. The bytecode excludes the extra white spaces and user comments.

5.4.2 Nokia Mobile Internet Toolkit 3.1

The Nokia Mobile Internet Toolkit comes with a reference implementation emulator that supports the complete WAP 2.0 specification, including text generation technologies such as XHTML and CSS. In addition, a range of Nokia handset simulators are available via separate downloads. These simulator are based on

commercially available Nokia devices and enable the previewing of different applications, including those based on WAP and MMS. This toolkit is released on the 4 July 2002.

This toolkit requires the installation of the JavaTM Runtime Environment (JRE) 1.3.1 software. The Nokia Mobile Internet Toolkit 3.1 has a server simulator based on the Nokia Active Server if a WAP Gateway is unavailable. To download the Nokia Mobile Internet Toolkit 3.1, go to http://www.forum.nokia.com/. The download installation file for this version is NMIToolkit3.1install.exe.

[Foo, Soo Mee *et al*, 2001]

After installation, launch the Nokia Mobile Internet Toolkit 3.1 by clicking the Start button on the task and select Programs => Nokia Mobile Internet Toolkit 3.1 => Mobile Internet Toolkit 3.1. The figure 5.3 is depicting the Nokia Mobile Internet Toolkit 3.1 window.

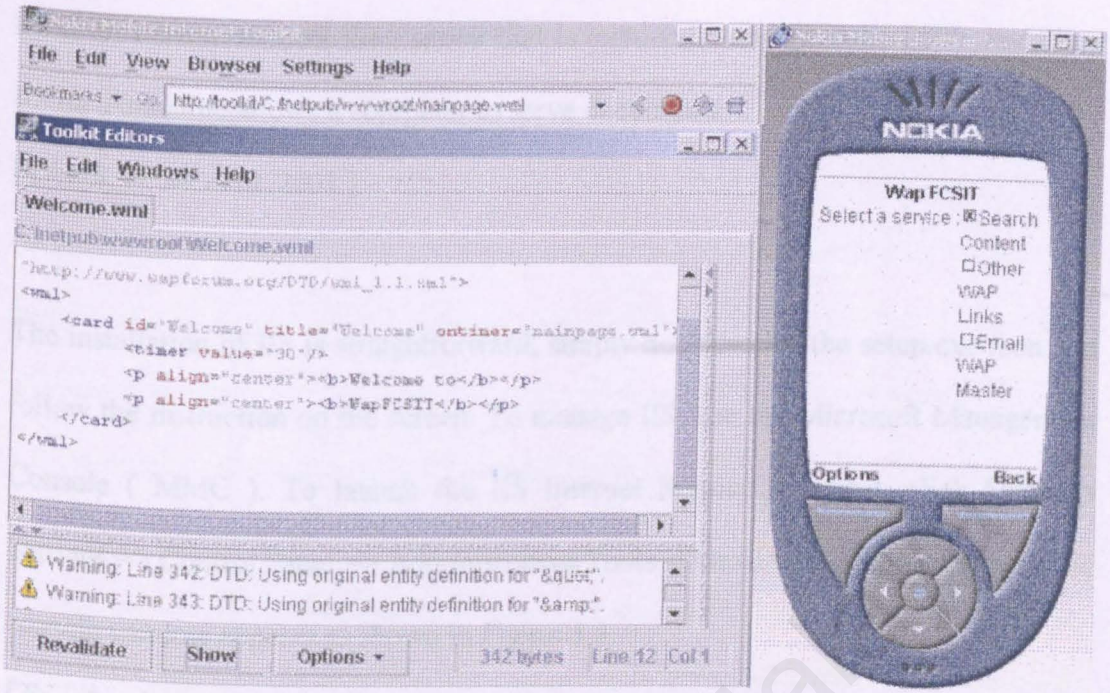


Figure 5.3 : The Nokia Mobile Internet Toolkit window

5.4.3 JavaTM Runtime Environment (JRE)

The JavaTM Runtime Environment contains the Java virtual machine, runtime class libraries, and Java application launcher. It is not a development environment and does not contain development tools such as compilers or debuggers. The JavaTM Runtime Environment (JRE) 1.3.1 or later is needed before installing the Nokia Mobile Internet Toolkit 3.1. The software can be obtained from Sun Microsystems, Inc., web site at http://www.javasoft.com/products/jdk/1.3/jre/index/html.

5.4.4 Web Server – Microsoft Internet Information Server Version 5.0 (IIS)

A web server is used instead of a WAP server because this system is just a simulation application. Moreover, the tools used in this project have their own WAP server simulator.

IIS is an enterprise-level Web server that is included with Windows 2000. Installing IIS on a machine allows a computer to serve documents.

[Deitel, H. M. *et al*, 2001]

The installation of IIS is straightforward; simply double-click the setup.exe icon and follow the instruction on the screen. To manage IIS, use the Microsoft Management Console (MMC). To launch the IIS Internet Service Manager, click Start => Settings => Control Panel => Administrative Tools => Internet Service Manager. The console window appears as shown in Figure 5.4.

[Foo, Soo Mee *et al*, 2001]

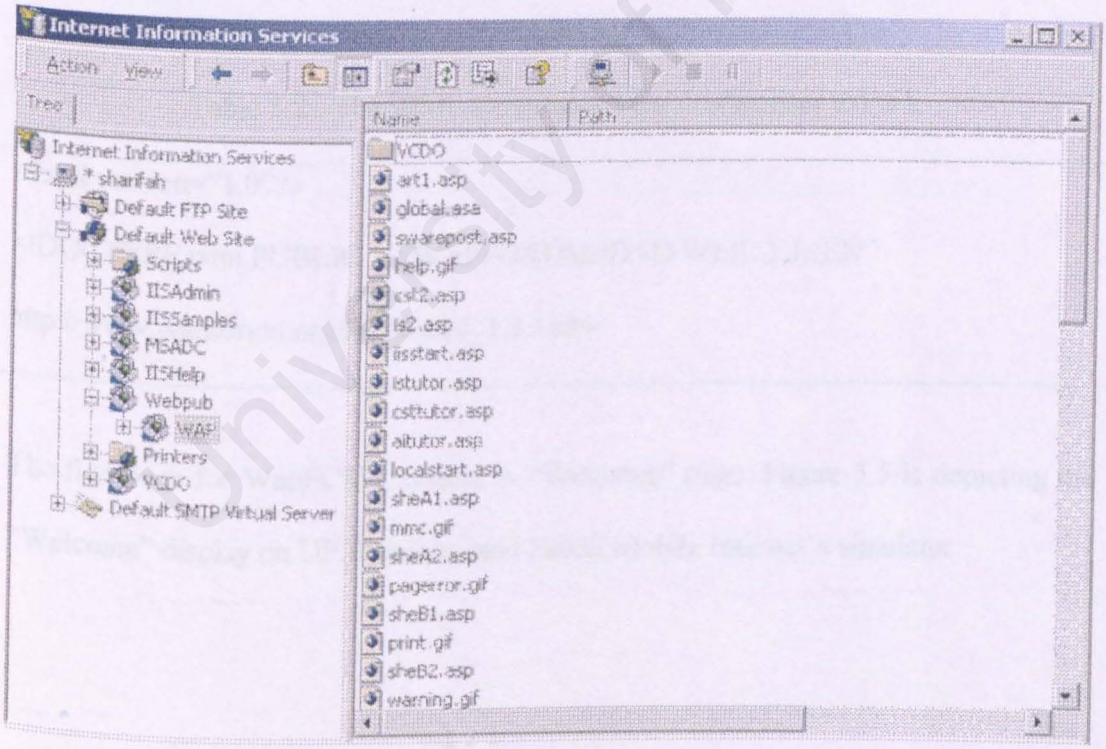


Figure 5.4 : IIS console window

5.5 Coding Implementation

5.5.1 WML implementation

WML pages are called DECKS. They are constructed as a set of CARDS, related to each other with links. When a WML page is accessed from a simulator, all the cards in the page are downloaded from a web server. WML document is an XML document. The DOCTYPE is defined to be wml, and the DTD (is shown in Figure 5.2) is accessed at www.wapforum.org/DTD/wml_1.1.xml.

The document content is inside the <wml>...</wml> tags. Each card in the document is inside <card>...</card> tags, and actual paragraphs are inside ... tags. Each card element has an id and a title.

Table 5.2 : The WML Document Type Definition (DTD).

```
<?xml version="1.0"?>
<!DOCTYPE wml PUBLIC "-//WAPFORUM//DTD WML 1.1//EN"
http://www.wapforum.org/DTD/wml_1.1.xml>
```

The first page for WapFCSIT system is "Welcome" page. Figure 5.5 is depicting the "Welcome" display on UP.Simulator and Nokia Mobile Internet's simulator.

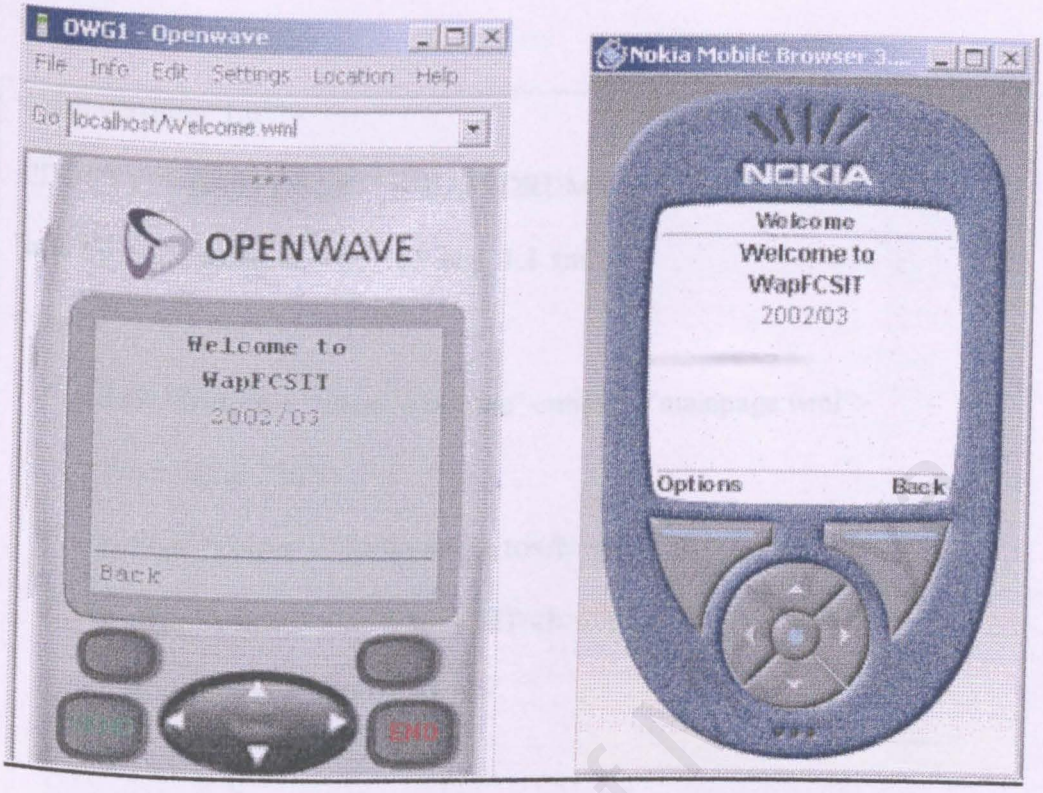


Figure 5.5 : Welcome Screen

After pressing the "OK" key pad, the user is linked to the selected option page.

Welcome.wml module

```
<?xml version="1.0"?>
<!DOCTYPE wml PUBLIC "-//WAPFORUM//DTD WML 1.1//EN"
"http://www.wapforum.org/DTD/wml_1.1.xml">
<wml>
   <card id="Welcome" title="Welcome" ontimer="mainpage.wml">
      <timer value="30"/>
      <p align="center"><b>Welcome to</b></p>
      <p align="center"><b>WapFCSIT</b></p>
      <p align=”center”>2002/03</p>
   </card>
</wml>
```

Figure 5.6 is showing the main page display on both simulators.

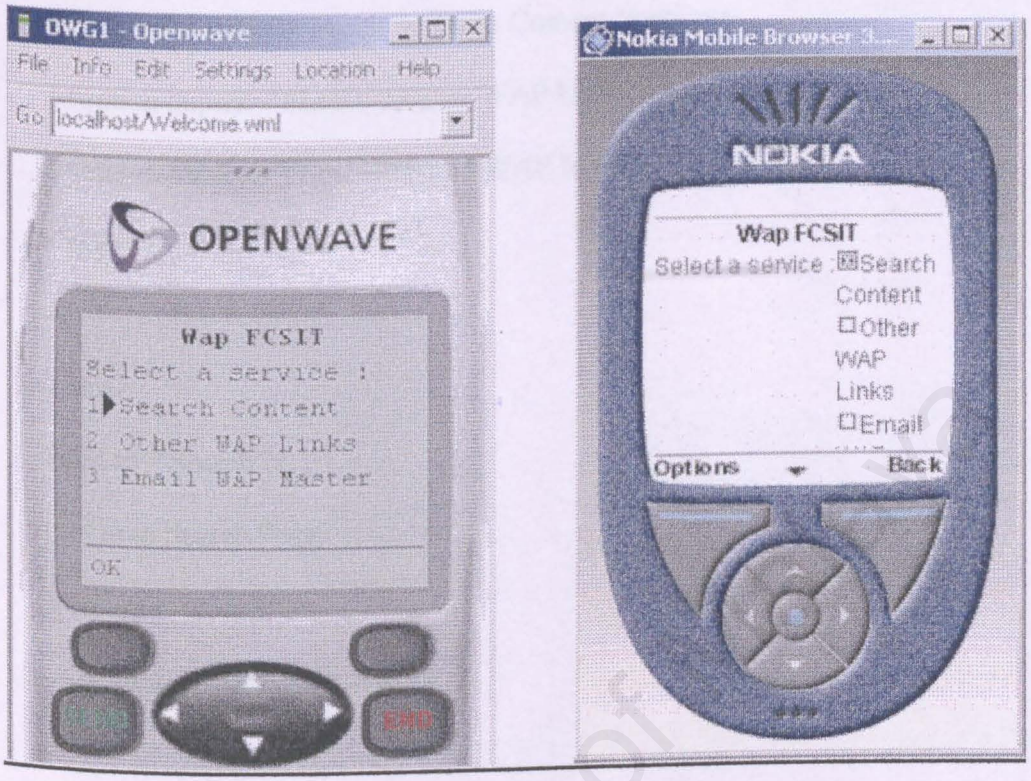


Figure 5.6 : Main page screen

Mainpage.wml module

Example of source code for main page of the application is depicted as below :

```
<?xml version="1.0"?>
<!DOCTYPE wml PUBLIC "-//WAPFORUM//DTD WML 1.1//EN"
"http://www.wapforum.org/DTD/wml_1.1.xml">
<wml>
  <card id="mainpage">
  <p align="center"><b>Wap FCSIT</b></p>
  <p>Select a service :
```

```
<select>
<option onpick="#Search">Search Content</option>
<option onpick="#Links">Other WAP Links</option>
<option onpick="#Email">Email WAP Master</option>
</select>
</p>
</card>
<card id="Search">
<p>Go to Search Page
<do type="accept">
<go href="Searchpage.wml"/>
</do>
</p>
</card>
.....
</wml>
```

WapFCSIT has 2 options in retrieving the information, hyperlink option and search option. Figure 5.7 a) is showing the hyperlink option display and figure 5.7 b) is showing the search option display.

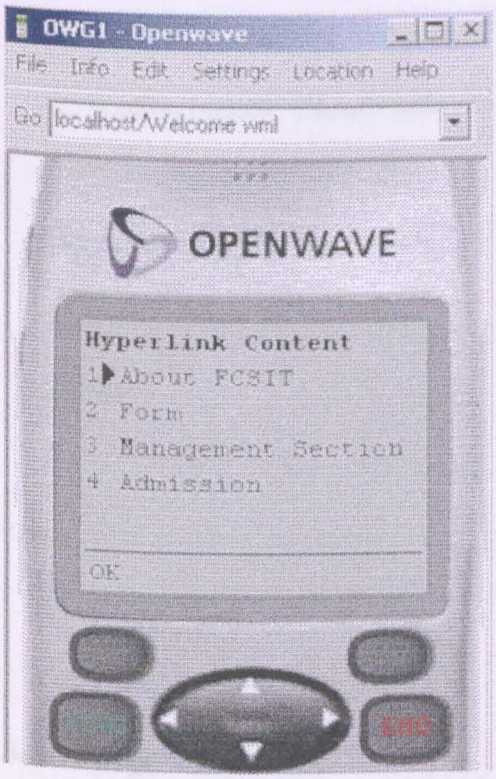


Figure 5.7 a) and b) are showing the hyperlink option and search option displays

Hyperlink.wml module

```
<?xml version="1.0"?>
<!DOCTYPE wml PUBLIC "-//WAPFORUM//DTD WML 1.1//EN"
"http://www.wapforum.org/DTD/wml_1.1.xml">
<wml>
  <card id="hyperlink.wml">
  <p><b>Hyperlink Content</b></p>
  <p>Hyperlinks :
    <select>
      <option onpick ="#About">About FCSIT</option>
      <option onpick ="#Form">Form</option>
```

```
    <option onpick ="#Management">Management Section</option>
    <option onpick ="#Admission">Admission</option>

  </select>
 </p>
 </card>
.....
</wml>
```

Searchpage.wml module

```
<?xml version="1.0"?>
<!DOCTYPE wml PUBLIC "-//WAPFORUM//DTD WML 1.1//EN"
"http://www.wapforum.org/DTD/wml_1.1.xml">
<wml>
 <card id="Searchpage">
 <p><b>Search Content :</b>
 <select>
   <option onpick="#hyperlinkOpt">Hyperlink Option</option>
   <option onpick="#searchOpt">Search Option</option>
 </select>
 </p>
 </card>
```

```
<card id="hyperlinkOpt">
<p>Go to hyperlink page
 <do type="accept">
  <go href="hyperlink.wml"/>
 </do>
</p>
</card>

<card id="searchOpt">
<p><b>Search for :</b>
<select>
   <option onpick="#Calendar">Calender</option>
   <option onpick="#DeptLec">Dept_Lecturers</option>
   <option onpick="#DeptDetails">Department Details</option>
</select>
</p>
</card>
……
</wml>
```

Figure 5.8 is showing the search screen and the result screen when the users key in the data in the simulator.

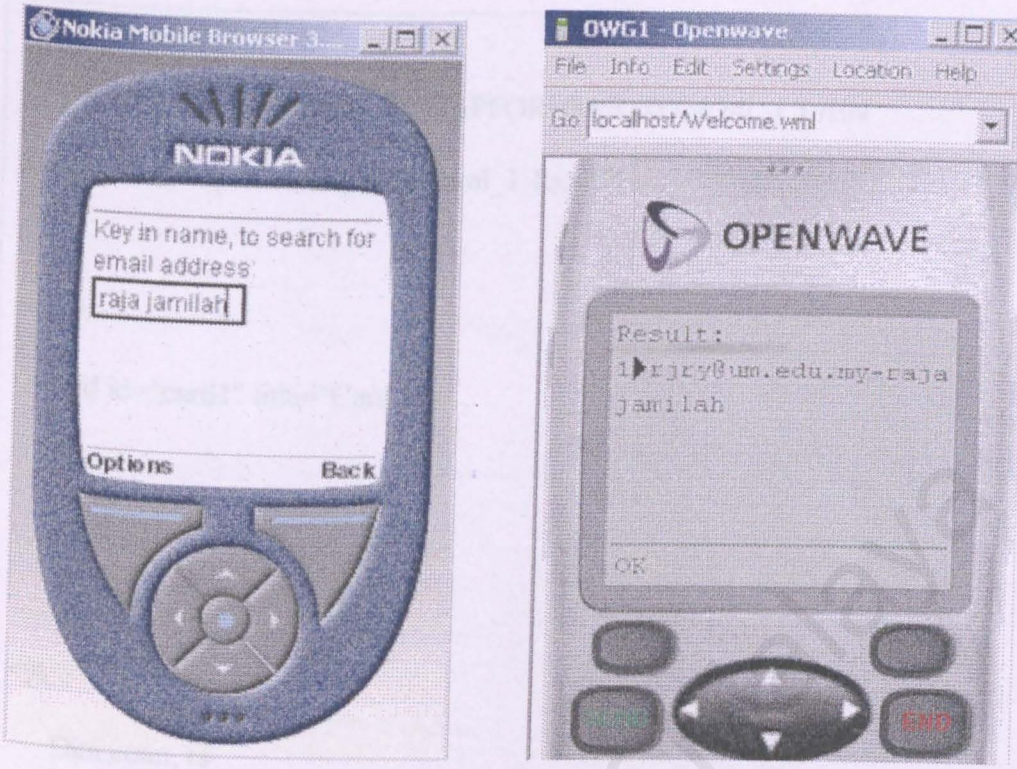


Figure 5.8 : Search page and result page

5.5.2 ASP implementation

When the user key in the data, the system will search for the information needed in the database that is stored in the Open Database Connectivity (ODBC). ODBC is based on SQL as a standard for accessing data. ASP is used to generate the WAP content in the system. There are many ASP modules in the WapFCSIT system. One of the examples is, "sware" module. This module is used to retrieve information in the database regarding the lecturers in the Software Engineering department.

Sware.asp module

```
<% Response.ContentType = "text/vnd.wap.wml" %>
```

```
<?xml version="1.0"?>
<!DOCTYPE wml PUBLIC "-//WAPFORUM//DTD WML 1.1//EN"
"http://www.wapforum.org/DTD/wml_1.1.xml">

<wml>
 <card id="card1" title="Card 1">
   <p>
     Result:

<%
    Dim conn, rs
    Set conn = Server.CreateObject("ADODB.Connection")
    Set rs  = Server.CreateObject("ADODB.Recordset")

    conn.open "Provider=Microsoft.Jet.OLEDB.4.0;Data Source=" & _
    Server.MapPath("wapDB.mdb") & ";"

    sql="SELECT * FROM Lecturer WHERE Department='SE' AND Name LIKE
'%" & _
       Request.QueryString("searchkey") & "%'"
     Set rs=conn.Execute (sql)
    if rs.EOF then
    Response.Write "Not found!"
    else
```

```
    Response.Write "<select name='Lecturer'>"
    While not rs.EOF
      Response.Write "<option value='" & rs("Name")& "'>" & _
      rs("Email") & "-" & _
      Request.QueryString("searchkey") & _
      "</option>"
      rs.MoveNext
    Wend
    Response.Write "</select>"
    end if
    rs.Close
    conn.Close
    Set rs=Nothing
    Set conn=Nothing
%>
  </p>
 </card>
</wml>
```

5.5.3 Checking for errors in coding

Developer can compile WML documents in the simulator. Figure 5.9 is showing the display when any errors occurred in a WML documents. Developer can checks the

error in details as shown in figure 5.10. Phone Information window by UP.Simulator will shows if any errors occurred. After the developer has corrected the errors, the simulator will generate the codes and display the output. As for ASP documents, errors are check by browsing the ASP documents in the Internet Explorer. Once the document is free from errors, Internet Explorer will display the output.

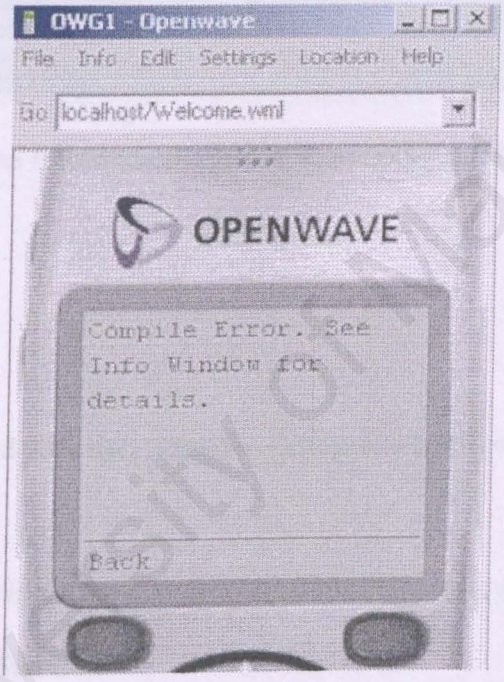


Figure 5.9 : Simulator is showing errors have occurred in the WML documents.

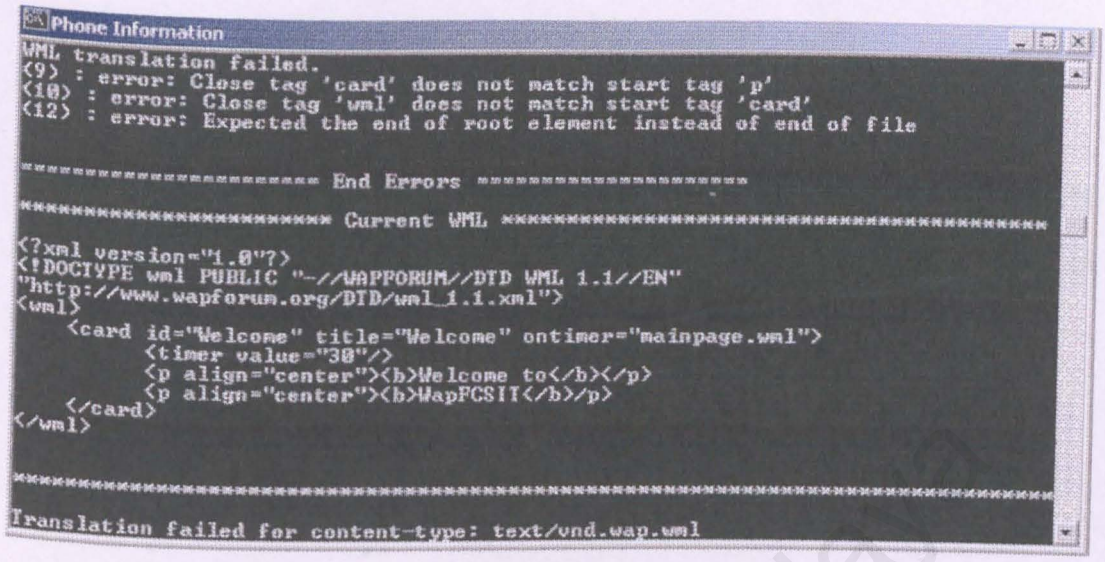


Figure 5.10 : Phone Information window is showing in which line the errors occurred.

5.6 Conclusion

Below is the steps used to write, compile, debug and run the WapFCSIT system's coding :-

1. Write the codes in notepad, save it as .wml or .asp in a specific directory.
2. Launch the UP.Simulator.
3. Compile the codes by typing the file name in the "Go" field of the simulator.
4. If the documents cannot be displayed, correct the error.
5. Repeat step 3 until compilation is completed.
6. Start the web server.
7. Change to the directory where files are located. For examples, save the Welcome.wml in the c:\inetpub\wwwroot\ (default directory).
8. Run the application on the simulator by typing in the "Go" field :- http://localhost/webpub/WAP/Welcome.wml

9. Testing (will be discussed in chapter 6 in details).

From what has been explained in this chapter, it can be summarized that the coding phase was a very complicated phase and the longest duration in the process of developing the WAP Web Search system (WapFCSIT).

CHAPTER 6 : SYSTEM TESTING

6.0 Introduction

In ensuring the quality of software or a system, system testing need to be performed and it is one of the critical elements. This process involves careful examination of all the design specifications and coding process that has been performed along the system development process.

Testing is also performed to ensure that all the modules developed are free from any errors that can cause unreliability to the system from performing as required and to produce result as desired. Usually testing is performed using sample data and logics that are used in coding.

A good test is a test that is able to identify all the errors that are not detected during the analysis phase, design phase and coding phase. The main objectives in system testing are:

i. **Identify errors**

   Detailed checking is being performed to every function and behavior of the system to identify errors in the system.

ii. **Removing errors**

Errors are removed from the system by compiling the codes after detecting the cause of errors or by debugging the system.

iii. **Regression test**

To identifies new faults that may have been introduced as current ones are being corrected.

6.1 System Testing

System testing is ideally performed by developers using an environment similar to the production environment. This testing ensures that the system meets externally observable requirements including :

- Functional requirements, for example, "The system shall allow users to view their requested result or output."
- Derived requirements such as performance, robustness, and scalability.
- Usability requirements.

[Bennett, C., 2001]

The main intention of the testing process is to evaluate how much fault can be reduced in the program or in the module itself. The correction process on demonstration is against the meaning of testing. Testing is performed on the program to demonstrate existing fault. Since the main objective of testing is discovery of faults, all the faults that might lead to failures during actual system usage will be eliminate to ensure successful testing result. Fault identification is a process to

determine fault or the cause of it, while fault correction is a process to make changes to eliminate fault.

To test the application, firstly, all cards must go through unit testing which is the simplest test of all, followed buy module testing, which covers a wider scope of testing than unit testing. It takes a module and tests it out thoroughly. The result or output will be compared with the expected result. Then, an integration testing is performed to ensure the usability of the application. Furthermore, all links leading to all the modules are tested out. An important point to remember when naming the link is; the name of the links should be clear and not be misleading.

In the testing process of WAP Web Search Engine system, there are six main tests that have been conducted to ensure the system works as a whole. The testing stages are :-

i. Unit Test
ii. Integration Test
iii. Function Test
iv. Regression Test
v. Stability Test
vi. Usability Test

Testing sequence is as shown in Figure 6.1. Test performed on WAP Search system is a bottom-up testing technique that is starting the test from the smallest unit until the system is entirely tested including the installation of the system.

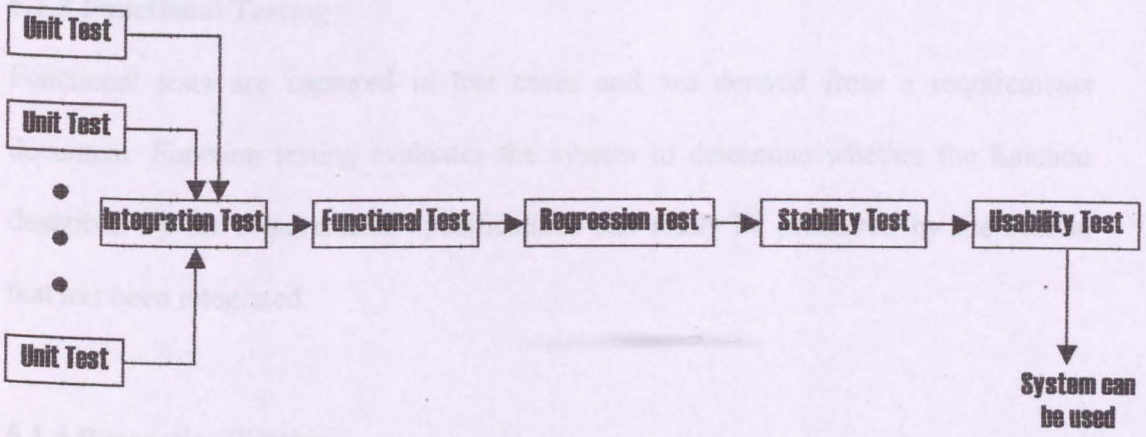


Figure 6.1: Testing Steps

6.1.1 Unit Testing

Unit testing is done by reading lines of code that has been written during the development of a module to identify any syntax errors, data and algorithmic errors. The programmer will repair these faults. After unit testing, the individual module will be compiled again to identify and fix any more errors incase there are still any errors undetected. This individual module will then be launch to ensure its effectiveness, accuracy and to see whether it functions as desired.

Unit testing is usually carried out by using the emulators. This testing includes test on every single program module components separately. Every file in the same module will interact internally or interact with other files in different module.

6.1.2 Integration Testing

This testing is done by taking the application from the top, following every links, using every available option and entering every possible data is necessary.

6.1.3 Functional Testing

Functional tests are captured in test cases and are derived from a requirements document. Function testing evaluates the system to determine whether the function described by the requirements specifications can really be presented by the system that has been integrated.

6.1.4 Regression Testing

The regression tests are made by re-executing some subset of the program's test cases, following changes to the application. Regression tests are used to verify that everything still works as it should.

6.1.5 Stability Testing

The stability test is done in the WAP Search System by trying to break the application by using weird user input.

6.1.6 Usability Testing

Usability testing is critical given the limited user interfaces offered by simulator, WAP phones and hand-helds. The testing is done by performing "cold tests" on people, who are given a brief description of the application and told to use it for a while.

Each of the stages is likely to highlight areas where work is needed. If it turns out that the application does not fulfill the initial requirements, then changes need to be made.

6.2 System Testing Technique

Techniques used for testing depends on the testing level that has been set. At unit testing level, white box technique has been used to determine errors as shown in Figure 6.2.

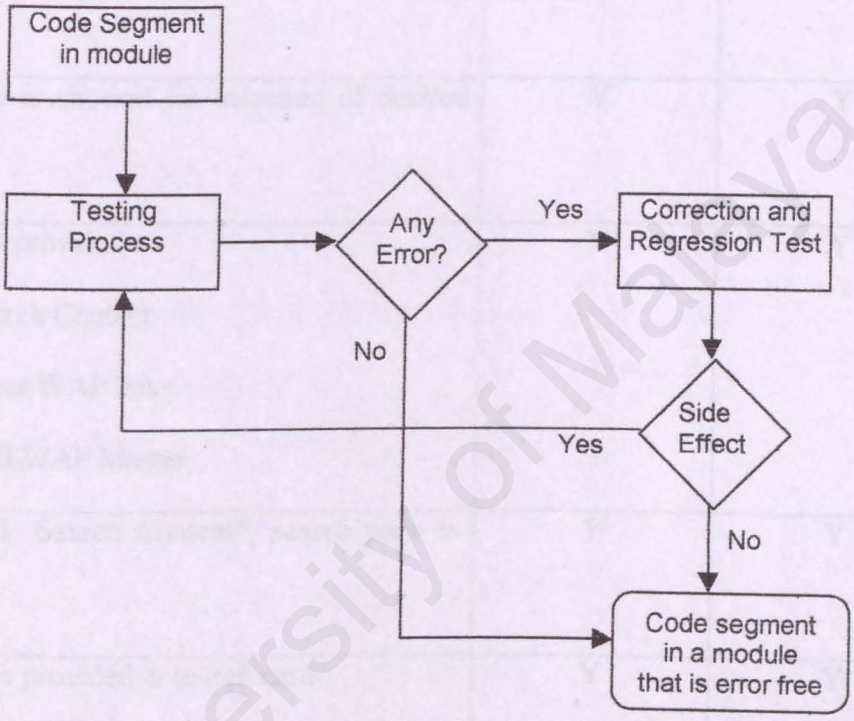


Figure 6.2: Unit Testing Scheme

6.3 User Acceptance Test (UAT) script

The UAT script is shown in Table 6.0. The testing below is done by using :

- UP.Simulator 4.1 provided by Phone.Com
- Nokia Mobile Internet Toolkit 3.1

Table 6.0 : User Acceptance Test Script.

Description **(Y-Yes, N-No)**	**Up.Simulator**	**Nokia Mobile Internet Toolkit**
Welcome WapFCSIT card – the first card. Automatically link to next card after a few seconds.	Y	Y
Main page is showed for selection of desired option.	Y	Y
Three links provided : 1. Search Content 2. Other WAP links 3. Email WAP Master	Y	Y
If select "1. Search Content", search page is displayed.	Y	Y
Two options provided in search card : 1. Hyperlink option 2. Search option	Y	Y
If select "1. Hyperlink option", hyperlink card is displayed along with the information needed.	Y	Y
If select "2. Search option", search card is displayed.	Y	Y
Three selections provided in search option : 1. Calendar	Y	Y

2. Departments and Lecturers 3. Department details		
If select "1. Calendar", calendar card is displayed. Users need to key in the keyword to retrieve the information. Then press "Search" keypad. The result is then displayed.	Y	Y
If select "2. Departments and Lecturers", Departments and Lecturers card is displayed. Users need to key in the keyword to retrieve the data needed. Then press "Search" keypad. The result card display the output.	Y	Y
If select "3. Department details", department details card is displayed. Users need to key in the keyword. Start searching by pressing the "Search" keypad. Then the screen displays the output.	Y	Y
If select "2. Other WAP links", the links card is displayed along with the other WAP links provided.	Y	Y
If select "3. Email WAP Master", the email card is displayed. The email address is displayed.	Y	Y
If users click or press the key pad on the email	X	X

address, it will go to the message box to compose.		
If the users have key in the wrong keywords or an invalid data, the screen displays "Not found!"	Y	Y
Type the URL in the "Go" field to restart the WapFCSIT site. The welcome screen appears.	Y	Y

6.4 User's System Evaluation

A form of questionnaires were distributed among the student of Computer Science and Information Technology (FCSIT) UM. The questionnaires is distributed to evaluate the WapFCSIT system on the performance, the functionality and the usability of the system. Basically, the evaluation came up with positive reviews. The evaluation forms were distributed among 20 users. Below is showing the percentage of the evaluation in the graph charts based on the questionnaire forms attached at the end of the report.

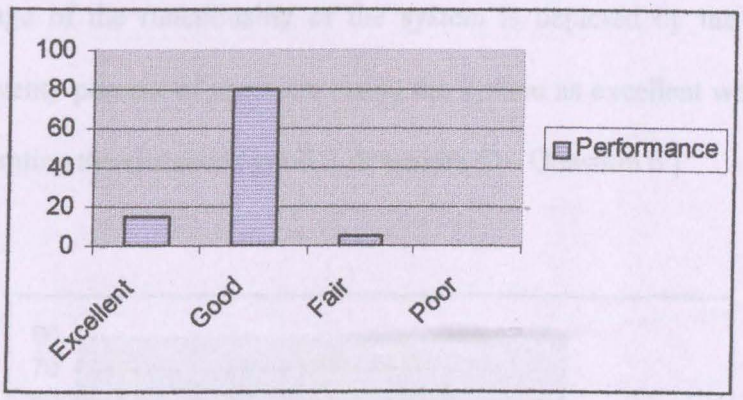


Figure 6.3 : Graph chart on the performance evaluation

In the figure 6.3 as above, the chart is showing the percentage of the system performance. Fifteen percent of users are saying the performance is excellent, eighty percent of users are saying it is good while another five percent of users are saying the system is performing moderately. [Appendix C – Question 5]

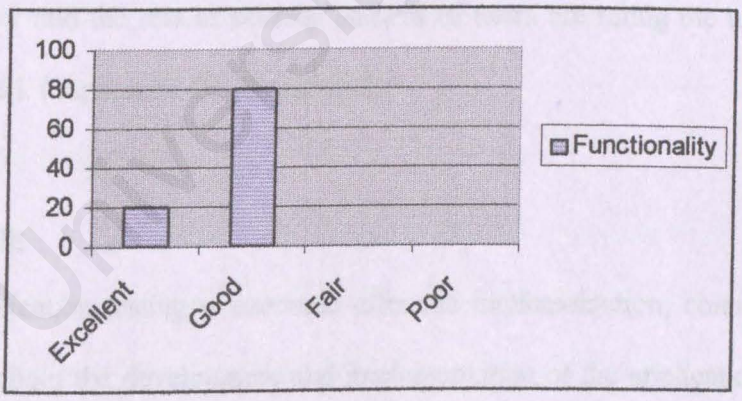


Figure 6.4 : Graph chart on the functionality of the system

The percentage of the functionality of the system is depicted by the figure 6.4. It shows that twenty percent of users are rating the system as excellent while the rest of the users are rating the system as good. [Appendix C – Question 6]

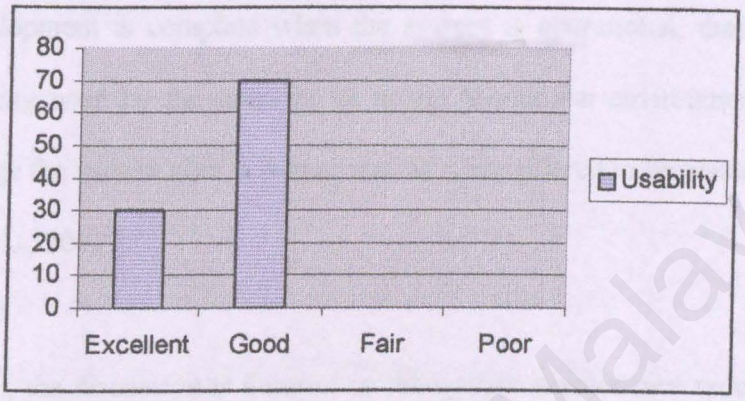


Figure 6.5 : Graph chart on the usability of WapFCSIT system

Figure 6.5 is showing that, thirty percent of users are saying the system is excellent in the usability and the rest of seventy percent of users are rating the usability of the system as good. [Appendix C – Question 8]

6.5 Conclusion

Although application testing is executed after the implementation, continuous testing is done throughout the development and implementation of the application. The WAP Search Engine application should be tested thoroughly to ensure its reliability, its efficiency and its usability. It is very important that the user can understand by just one look on the interface of the application. Usually a good application is able to fulfill the user requirement and keep running without much error.

CHAPTER 7 : SYSTEM MAINTENANCE AND EVALUATION

SYSTEM MAINTENANCE

7.0 Introduction

System development is complete when the system is operational, that is, when the system is being used by the users in an actual production environment. Any work done to change the system after it is in operation is considered to be maintenance.

[Pfleeger, S. L., 2001]

In this section, the discussion is focused on the system maintenance requirements and how the system can be maintained when the functional requirements tends to change. This is to give guidance and understanding to users that will maintain the system so that it will not affect the system operations entirely during maintenance. Besides that, system recovery method is also included for this system.

7.1 Maintenance Requirements

Generally, a system has to go through maintenance in a routine basis to make sure the system is operating at optimum level. Maintenance has to be made to this WAP Web Search system because of several reasons such as:

i. **Additional Record**

Since WAP Web Search Engine system is based on the database to search for records and information, additional information such as lecturer's

name, emails, tutor's name, calendar, the session and other information will increase the amount of data in the database of the system. The size of storage space available needs to be increased to store more incoming data. It is clear that the increment in the record will result in the increment of storage space for the database.

ii. **Outdated Data Contents**

Some data or any information that needs to be removed and the outdated record regarding the information that can be retrieved in the database, need to be erased from the database table by the database administrator. Documents or data for outdated records need to be removed from the database, for instance one lecturer has retired and his name needs to be removed, so that the database is free from unused data and require less storage space in the system.

7.1.1 System Maintenance Methodology

This system can be maintained through various methods such as:

- **Update the database**

To update the database, the database administrator needs to open the Microsoft Access and select the required table to change the data in it. The database tables are organized according to a specific category so it would be easy to select the table in which the information need to be updated. For security reason, the

database is secured with a password so that only the database administrator can change or update the information in the database.

- **Disaster Recovery Plan**

Disaster recovery plan is made to provide support to system's operation incase a disaster occurs. The main contents of the system including the database has to be duplicated in a different storage device such as backup storage media, backup tape, diskette and other media storage device. If a disaster occurs, the system can still be retrieved and it does not have to be redevelop. The contents of the WAP Web Search System's database along with other documentations must be duplicated in the backup device from time to time so that the backup data stored stay updated.

SYSTEM EVALUATION

7.2 Introduction

The best way to develop a system is to involved system evaluation phase in the system development life cycle. This is the phase where a developer can analyze how successful the system that has been developed has reached its objective. Usually the developer will receive responses from users to evaluate a system.

7.2.1 Objective Achievement

The overall performance of the WAP Web Search Engine System reaches the objectives stated for the system. The system is fully functional and fulfills all the desired criteria set by the developer and the user.

7.2.2 Problems and Solutions

In developing this system, there are several problems confronted by the developer. Some of the problems can be solved easily but there are others that were unable to be solved by the developer alone. The developer obtains some help from many parties to solve all the problems that occur. There are a few problems during the development phase and the testing phase of the system, the problems are stated below in Table 7.0:

Table 7.0 : Problems and Solutions table

Problems	Solutions
Insufficient reference material At the beginning of the project, the developer had insufficient reference material to develop the system. Reference material at the market is sold at a very high price and the reference material in the library is limited and most of it is outdated.	The developer manage to overcome the problem by taking several alternatives such as borrowing reference books from friends besides having to buy some books that are appropriate in developing the system. The Internet also provides relevant information regarding the system that is being developed. The developer also joins discussion forums in the Internet regarding WAP to obtain extra knowledge regarding the programming languages and other information related to the WAP Search Engine System.

Lack of ability Lack of ability in the WML and ASP programming languages and Microsoft Access 2000 had cause the developer to have problems at the beginning of the project.	Finally the problem is solved by the developer. It takes quite a long time for the developer to master all the skills needed because the developer has to start from the very basic. The developer also gain help from friends and virtual friends from the Internet.
Problem in linking In the beginning process of the system development, developer had problems in linking the cards and decks in the system. Other than that, the problem in linking also occurs in ASP documents with Microsoft Access database.	Referring books and Internet resources regarding the navigation methods to link the cards and the decks in WML. Also, studying the books and other reference materials in using ASP to implement data-based WAP applications.
Incomplete database design The database design proposed in Chapter 4 is incomplete. More tables are required to store all the data appropriately.	Developer had to redesign a new database to fulfill the system requirements. More tables are added to ensure that all data can be stored properly according to the appropriate categories.

The WAP toolkit In the proposal it is stated that the WAP toolkit that is going to be used is the Nokia WAP Toolkit 2.0, but the toolkit is not available to be downloaded.	Therefore, the developer has to changed to UP.Simulator from Phone.com as the alternative. The new version of Nokia WAP toolkit is the Nokia Mobile Internet Toolkit 3.1 is downloaded instead of Nokia WAP Toolkit 2.0. The reason the developer is using more than one simulator is to test the system in a different environment so the WAP Search System would be compatible in any WAP devices.
Setting up tools Lack of knowledge in setting up web server configuration and the tools used in this system.	Confront the problem by surfing in the Internet, reading reference books and ask some of friends that used the same web server.

7.2.3 Strength

Usability

Basically, usability means the system is easy-to-use. In addition to this, usability concerns the general look and feel of the WAP application. Although there are some restrictions imposed by WAP and microbrowsers that make us design the application carefully, at the same time, these restrictions can actually make it easier to enforce good design rules and produce a streamlined product.

Keeping User Clicks to a Minimum

One of the features of this WAP application is for every click that users have made, they are provided with the information they are looking for. The substantial delay when navigating between decks is taken into consideration when designing the application.

Whenever possible, "Back" , "Main", or "Home" link is included to keep the user's option open. However, some WAP browsers do not allow for too many options to be provided at once, and it is better to limit the options to the most common ones.

Keeping User Input to a Minimum

One main feature in the WapFCSIT system is, users are required to key in input to search for information needed. Hence, it is necessary to make it simple and provides an intuitive way of entering data.

Redundancy and Content Organization

In terms of WAP application design, redundancy means allowing more than one way of doing the same thing. To handle the situation in this WAP Search system, the developer has made a lot of links so that in one card, it only contains related information briefly.

7.2.4 Limitations/Constraints

1. Limitation of capacity – there is no guarantee that a WML deck of more than 1024 bytes will be accepted by the current WAP browser.
2. Cost of using WAP is high – Not many students or users will use the system.
3. Not enough information to search – Not every information can fit in this system, for instance, student cannot retrieve notes from the WapFCSIT. Only brief information can be retrieved.

7.2 Future Enhancement

Nothing is perfect. No doubt this application contains some omissions and inaccuracies. Despite its future, the application can be further improved and enhanced to include more features and functions. May be by providing more information and by upgrading the WAP Search system to not just in FCSIT but also to other faculties in UM.

7.3 Knowledge gained

This project does push me up to another level that is full with new terms and technologies Through the application, theories learned in classroom can be applied to my practical work. For examples :

- Web server setup and configuration
- Wireless technology
- How to keep track of the ongoing development

- The importance of User Acceptance Test (UAT) and user's system evaluation questionnaires for system refinement process.

Other than that, I have learned something that is not been taught in classroom, for instance, the skills of sharing and communication and learning new programming languages. I believed the concept of gaining and contributing knowledge is something beneficial and this exposure will be very useful in the future.

7.4 Conclusion

From this chapter, all the problems and solutions taken by the developer had been discussed in details. Apart from that, all other evaluation had also been considered. Even though there are several limitations, it can be said that WapFCSIT has achieved its main objectives.

OVERALL SUMMARY

The WAP Web Search Engine system is also known as WapFCSIT system. This system is designed and developed for wireless devices users, especially for mobile phone users. The main function of this system is to search information regarding FCSIT while on the move. The WapFCSIT has 2 ways in retrieving the information, that is the hyperlink and the search options.

Although there are a lot of limitations for the WAP application but this system is still successfully developed with simple navigation for the usability of the WapFCSIT. The fact that WAP application is high in cost but the technologies is growing rapidly and wireless technologies have a high expectations in the future. May be now, the system will not be used widely but in the near future where almost everything is without wire then the system can be upgrade and will be implemented in wider range and the system is used not just in FCSIT.

The conclusion is WapFCSIT managed to achieve its objectives that is to create a wireless environment in searching and gaining information. Besides that, it is certain that all the functions and behaviors of the system fulfill the system's requirements.

Finally, all of the experience gained during the development of this system gives new knowledge regarding ways of developing a WAP Search system. Hopefully the system will meet user requirements and users will be able to gain benefit from it.

APPENDIX A : USER MANUAL

Introduction

Welcome to WAP Web Search Engine System. This system is named WapFCSIT. The WapFCSIT is a system specially developed to search data regarding the FCSIT information such as :

- Lecturers' email
- Tutors' email
- Details of every departments in FCSIT
- Events in semester 1, 2 and special semester
- The calendar to search for date of events

This WapFCSIT application is a mobile application that enables user to search for information regarding FCSIT using a WAP simulator. This is a simple application with easy-to-use interface. This system can be used by the students, lecturers or anyone who needs to retrieve information wirelessly. This system also provides two options in retrieving the information needed. The options are the hyperlink option and the search option.

Security preferences such as password protection to prevent access to unauthorized users is also available. Thus, increase the integrity of the database of the WapFCSIT system.

This user manual provides a step-by-step guide on how to use the core functions of the application.

1.0 Minimum Requirements

The minimal requirements to run WapFCSIT is listed below :-

1.1 Hardware Requirements :

- 300 MHz Pentium or faster processor
- 64 MB of RAM (128 MB recommended)
- 50 MB hard disk space
- Monitor (resolution 800 x 600)

1.2 Software Requirements :

- Windows 95/98/2000/NT
- A WAP phone simulator (UP.Simulator version 4.1 from Phone.com is highly recommended. This toolkit is freely available at **http://www.openwave.com**)

2.0 Deploying the WapFCSIT search engine system

1. Insert the WapFCSIT compact disc in to the CD-ROM drive.
2. Users must copy all the files in the CD in to the web server directory.
3. Start the web server.
4. Launch the UP.Simulator version 4.1.

5. Type the following in the 'Go' field :- localhost/webpub/WAP/Welcome.wml or http://localhost/webpub/WAP/Welcome.wml or localhost/Welcome.wml

   This will launch the WapFCSIT first card or first page in the simulator as the figure below :-

6. Exit from the simulator if finish.

7. Stop the server when finished.

The Basic Interfaces in WapFCSIT searching system

Figure 1 – Welcome Screen

This is the first card or first screen of the WapFCSIT application. It will automatically go to the next card or to the main page.

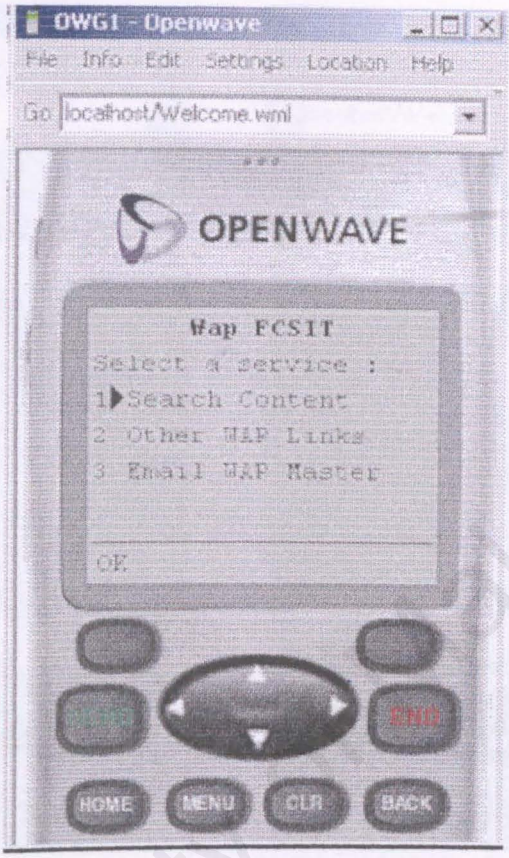


Figure 2 – Main page screen

Users can select on the options as above. Number 1 is the search content, number 2 is links to other WAP sites and number 3 is the email address of the WAP developer.

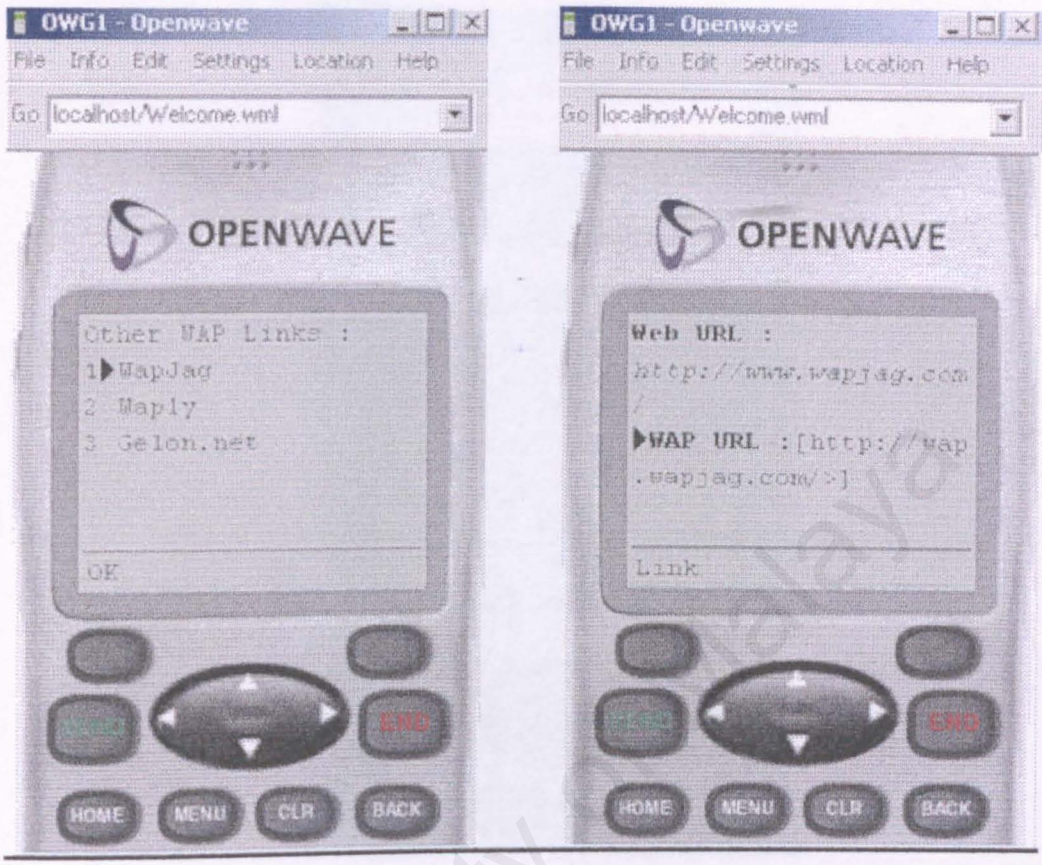


Figure 3 and 4 – Other WAP links screen

In this card, users can go to other WAP links available. Only 3 main WAP sites have been chosen as above.

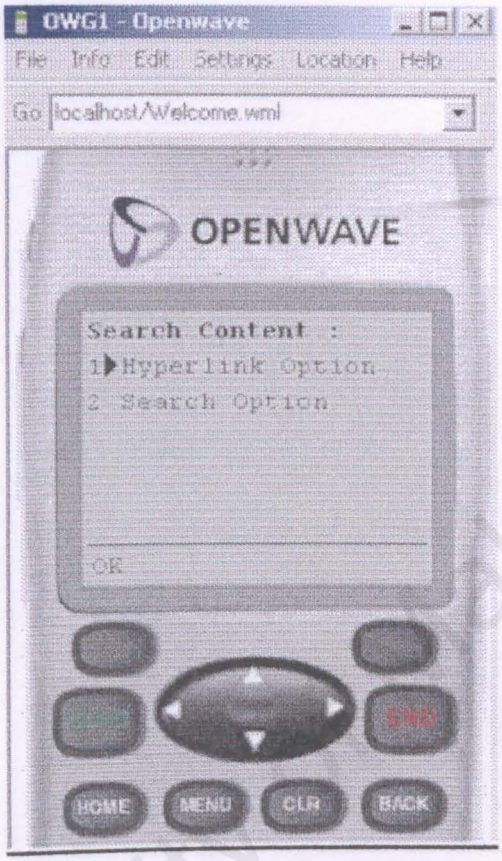


Figure 5 – Search content screen

In this page, users can select 2 options in retrieving the information, the hyperlink option and the search option.

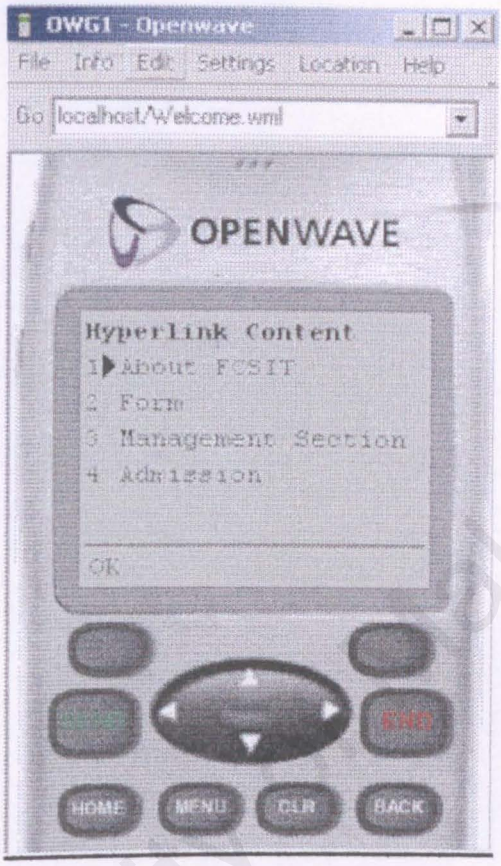


Figure 6 – Hyperlink option screen

If the users select on the hyperlink option, the users can retrieve information on the FCSIT details such as FCSIT address, email, telephone number, fax number and the URL. Other than that, users can gain information on where to get the application form, details on the management section and details on the admission.

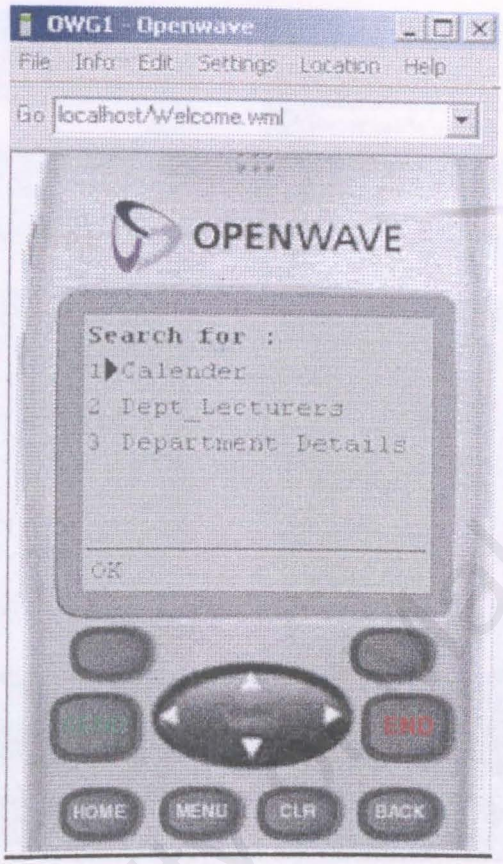


Figure 7 – Search option screen

There are 3 selection; calendar, department_lecturers and the department details.

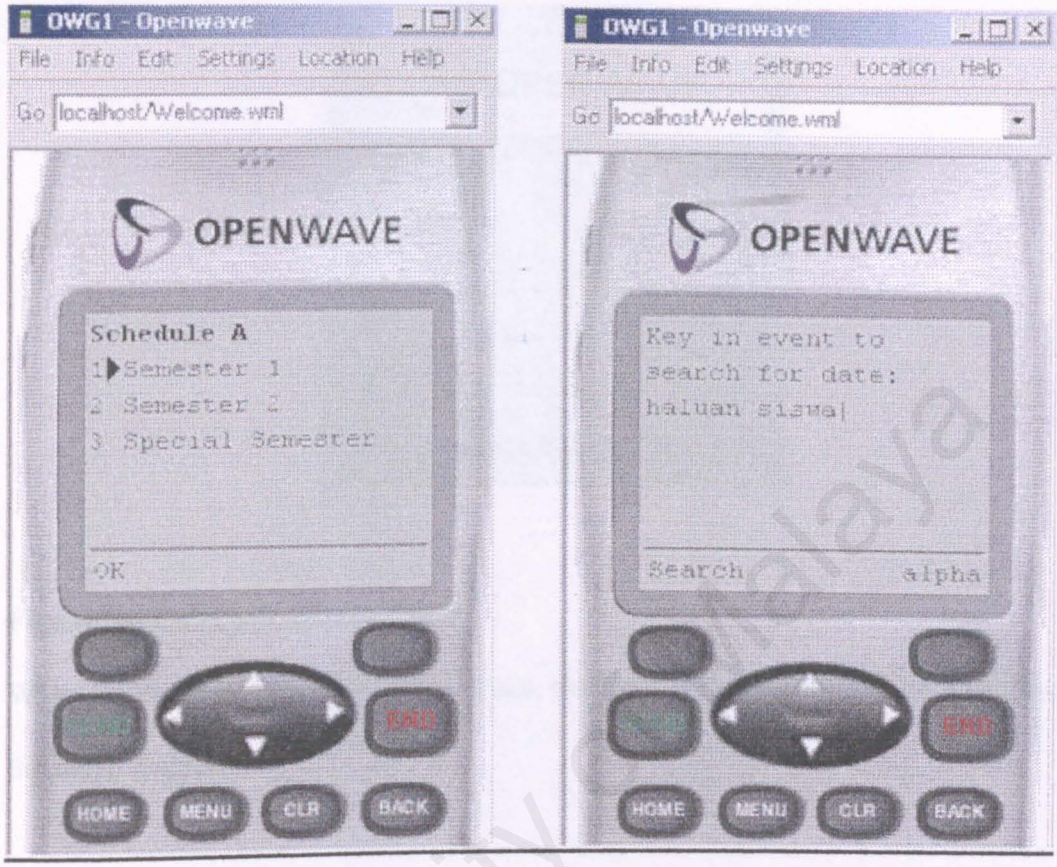


Figure 8 a) and b) – Search for calendar screen

Users can search information regarding the date and events in semester 1, 2 and special semester. Users will have to key in the events such as haluan siswa, orientation week or break to check on the date.

Figure 9 – Calendar result screen

When the users have key in the text area, the date of the events will be displayed on the result's screen.

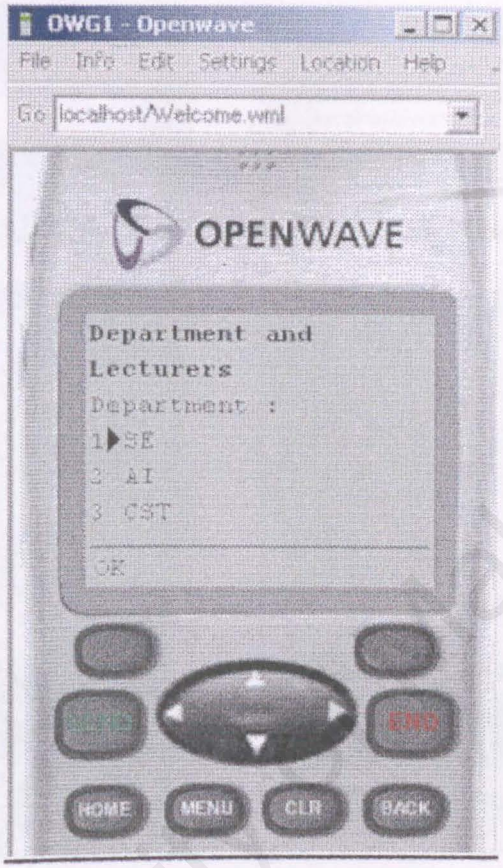


Figure 10 – Search for department and lecturers' details screen

Users can search information on lecturers' email, tutors and other details based-on the department.

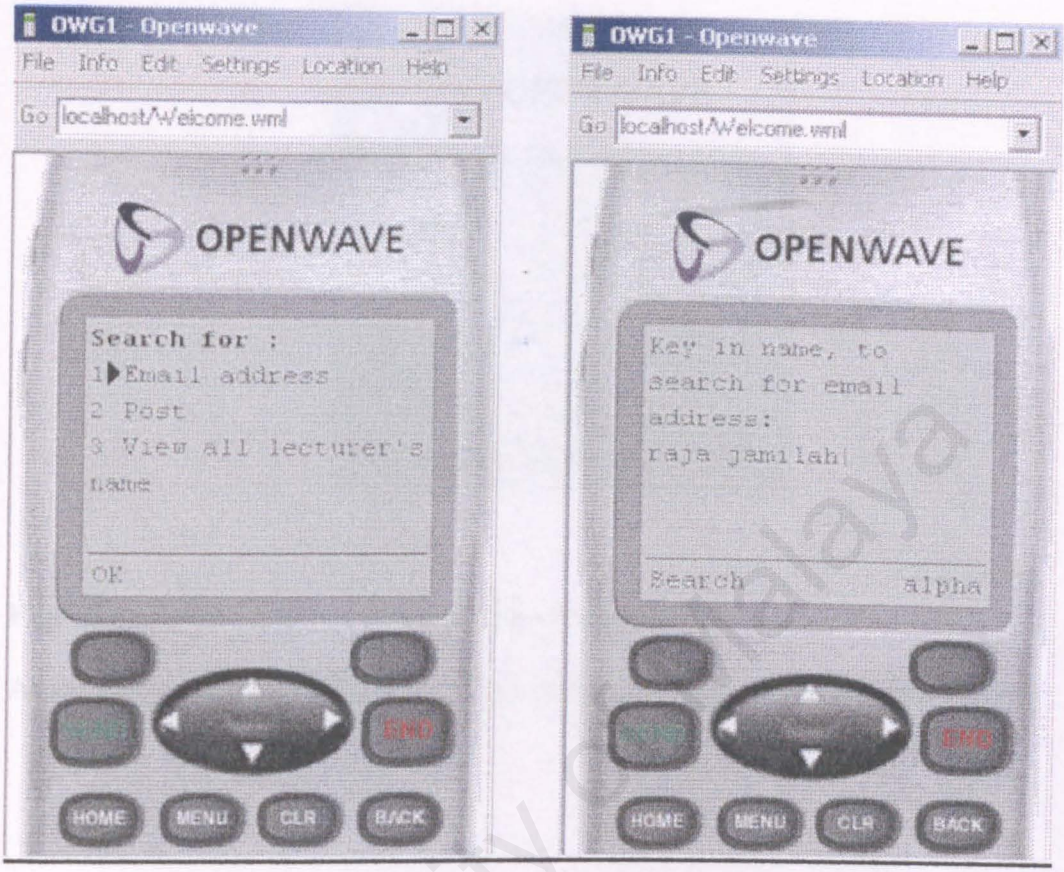


Figure 11 and 12 – Search for lecturers screen

Users can select on which information they want to view. For example (as shown on the figure above), users need to key in the lecturer's name and click on the 'Search' keypad.

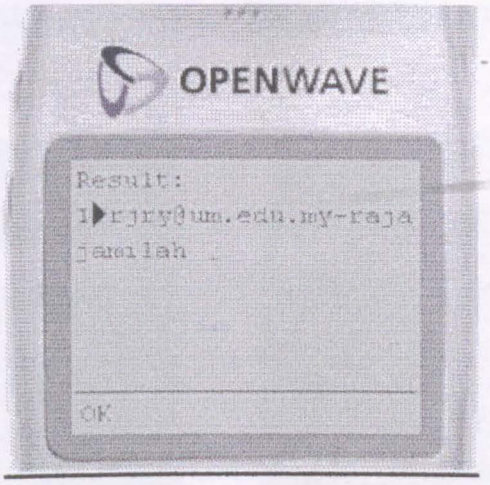


Figure 13 – Search lecturer's email result screen

As shown on the figure 13, the simulator screen will display the required result.

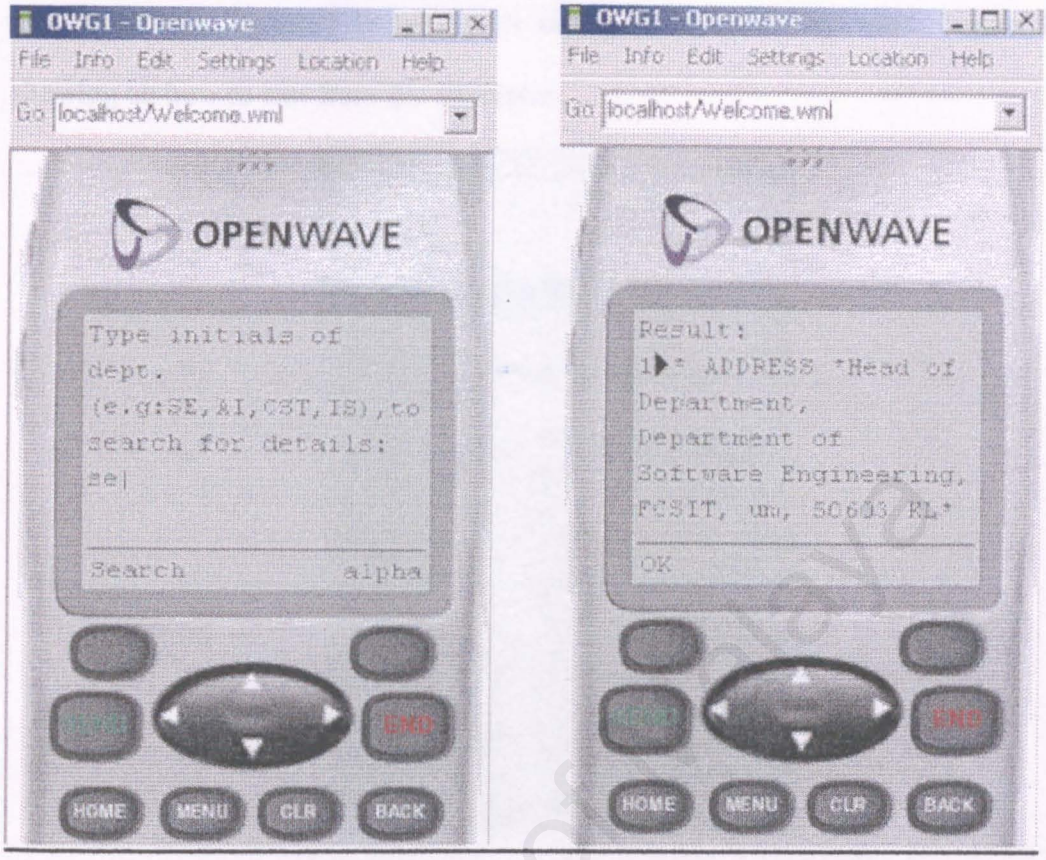


Figure 14 – Search department details screen

Users will have to key in the initials of departments to retrieve the data needed. SE is the initial of the department of Software Engineering, AI is for Artificial Intelligence department, CST is for Computer Systems and Technology department and IS is the initial for the Information System department. Once the users have key in the input, the simulator's screen will display the output (result page) as shown above.

Exit

Once the users have finished, she/he will just have to exit from the simulator. There is no exit screen required as users do not have to login and this system do not require

any passwords. In other words, users can exit anytime they want. Figure 15 is showing on how to exit from the simulator.

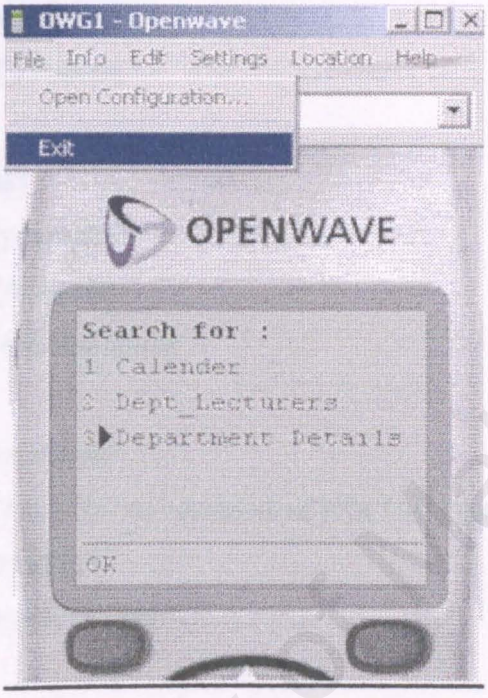


Figure 15 – Exit from the simulator

APPENDIX B : QUESTIONNAIRES

1. What is your gender?

   [√] Male [ ] Female

2. What is your age?

   [√] 15 to 25 years old

   [ ] 26 to 35 years old

   [ ] 35 years old and above

3. Your current occupation?

   [√] Student (Only for the residents of FSKTM, UMKL)

   [ ] Computer related

   [ ] Non-computer related

4. Do you own a mobile phone/PDA (Personal Digital Assistant)?

   [√] Yes (If yes, proceed to the question no. 5)

   [ ] No

5. Is it a WAP phone/PDA?

   [√] Yes (If yes, proceed to Section A)

   [ ] No (If no, go to Section B)

Section A

1. What do you use your phone/PDA for? (can tick more than one answer)

   [√] Internet/Browsing/Surfing

   [√] SMS text messaging

   [√] Other (Please specify) : make calls

2. Do you think WAP search engine in retrieving FCSIT information is useful?

   [✓] Yes

   [ ] No

3. If your previous answer is a "Yes", why?

   Please specify your reason : to get the current info about FCSIT

4. How would you rate WAP phones/PDAs?

   [ ] Excellent

   [✓] Good

   [ ] Average

   [ ] Poor

Section B

1. Are you considering upgrading your phone/PDA to WAP?

   [✓] Yes

   [ ] No

2. If no, reasons for not upgrading

   [ ] Lack of knowledge about WAP

   [ ] Poor value for money

   [ ] Don't think you need to

   [ ] Other (Please specify) : ----------

3. Do you think WAP is a fad or a future? (Please give comment)

   WAP extend the purpose of mobile phone where people can get the info ~~at~~ just at the tips of our finger.

Thank you for your time!

APPENDIX B : QUESTIONNAIRES

1. What is your gender?

   [ ] Male [✓] Female

2. What is your age?

   [✓] 15 to 25 years old

   [ ] 26 to 35 years old

   [ ] 35 years old and above

3. Your current occupation?

   [✓] Student (Only for the residents of FSKTM, UMKL)

   [ ] Computer related

   [ ] Non-computer related

4. Do you own a mobile phone/PDA (Personal Digital Assistant)?

   [✓] Yes (If yes, proceed to the question no. 5)

   [ ] No

5. Is it a WAP phone/PDA?

   [ ] Yes (If yes, proceed to Section A)

   [✓] No (If no, go to Section B)

Section A

1. What do you use your phone/PDA for? (can tick more than one answer)

   [✓] Internet/Browsing/Surfing

   [✓] SMS text messaging

   [ ] Other (Please specify) : making calls

2. Do you think WAP search engine in retrieving FCSIT information is useful?

   [/] Yes

   [ ] No

3. If your previous answer is a "Yes", why?

   Please specify your reason : can gain information while on the

4. How would you rate WAP phones/PDAs?

   [ ] Excellent

   [/] Good

   [ ] Average

   [ ] Poor

Section B

1. Are you considering upgrading your phone/PDA to WAP?

   [/] Yes

   [ ] No

2. If no, reasons for not upgrading

   [ ] Lack of knowledge about WAP

   [ ] Poor value for money

   [ ] Don't think you need to

   [ ] Other (Please specify) : ----------

3. Do you think WAP is a fad or a future? (Please give comment)

_____

_____

_____

_____

Thank you for your time!

APPENDIX B : QUESTIONNAIRES

1. What is your gender?

   [ ] Male [ ] Female

2. What is your age?

   [ ] 15 to 25 years old

   [ ] 26 to 35 years old

   [ ] 35 years old and above

3. Your current occupation?

   [ ] Student (Only for the residents of FSKTM, UMKL)

   [ ] Computer related

   [ ] Non-computer related

4. Do you own a mobile phone/PDA (Personal Digital Assistant)?

   [ ] Yes (If yes, proceed to the question no. 5)

   [ ] No

5. Is it a WAP phone/PDA?

   [ ] Yes (If yes, proceed to Section A)

   [ ] No (If no, go to Section B)

Section A

1. What do you use your phone/PDA for? (can tick more than one answer)

   [ ] Internet/Browsing/Surfing

   [ ] SMS text messaging

   [ ] Other (Please specify) : ----------

2. Do you think WAP search engine in retrieving FCSIT information is useful?

   [ ] Yes

   [ ] No

3. If your previous answer is a "Yes", why?

   Please specify your reason : _____

4. How would you rate WAP phones/PDAs?

   [ ] Excellent

   [ ] Good

   [ ] Average

   [ ] Poor

Section B

1. Are you considering upgrading your phone/PDA to WAP?

   [/] Yes

   [ ] No

2. If no, reasons for not upgrading

   [ ] Lack of knowledge about WAP

   [ ] Poor value for money

   [ ] Don't think you need to

   [ ] Other (Please specify) : ----------

3. Do you think WAP is a fad or a future? (Please give comment)

I think it would very useful to have a device with WAP capability. And I think it will save a lot of time if we can find any information at anytime / anywhere

Thank you for your time!

APPENDIX C : USER'S SYSTEM EVALUATION

1. Name : SALWA BT FAHARUDIN
2. Occupation : _____

3. What is your gender?

   [ ] Male [/] Female

4. If you have a WAP phone/wireless device, would you use this system ?

   [/] Yes

   [ ] No

5. How do you find the performance of WapFCSIT system?

   [ ] Excellent

   [/] Good

   [ ] Fair

   [ ] Poor

6. How would you rate the functionality of the system ?

   [ ] Excellent

   [/] Good

   [ ] Fair

   [ ] Poor

7. How does the links in the system facilitate your search/navigation in retrieving information ?

   [ ] Very Good

   [/] Good

   [ ] Fair

   [ ] Poor

8. Is the system easy-to-use (usability) ?

[✓] Yes

[ ] No

9. Are the instructions in the WapFCSIT system clear and easy to understand ?

[✓] Yes

[ ] No

10. Is the system response time acceptable ?

[✓] Fast

[ ] Acceptable

[ ] Not so fast

11. Overall, are you satisfied with WapFCSIT system ?

[✓] Yes

[ ] No

12. Give any suggestions or opinions to enhance the system requirements/needs.

_____

_____

_____

_____

Thank you for your time!

APPENDIX C : USER'S SYSTEM EVALUATION

1. Name : MOHD KHAIRIL MOHD LATIFF
2. Occupation : STUDENT

3. What is your gender?

   [M] Male [ ] Female

4. If you have a WAP phone/wireless device, would you use this system ?

   [M] Yes

   [ ] No

5. How do you find the performance of WapFCSIT system?

   [ ] Excellent

   [M] Good

   [ ] Fair

   [ ] Poor

6. How would you rate the functionality of the system ?

   [ ] Excellent

   [M] Good

   [ ] Fair

   [ ] Poor

7. How does the links in the system facilitate your search/navigation in retrieving information ?

   [M] Very Good

   [ ] Good

   [ ] Fair

   [ ] Poor

8. Is the system easy-to-use (usability) ?

[✓] Yes

[ ] No

9. Are the instructions in the WapFCSIT system clear and easy to understand ?

[✓] Yes

[ ] No

10. Is the system response time acceptable ?

[✓] Fast

[ ] Acceptable

[ ] Not so fast

11. Overall, are you satisfied with WapFCSIT system ?

[✓] Yes

[ ] No

12. Give any suggestions or opinions to enhance the system requirements/needs.

_____

_____

_____

_____

Thank you for your time!

APPENDIX C : USER'S SYSTEM EVALUATION

1. Name : zila
2. Occupation : student

3. What is your gender?

   [ ] Male [/] Female

4. If you have a WAP phone/wireless device, would you use this system ?

   [/] Yes

   [ ] No

5. How do you find the performance of WapFCSIT system?

   [ ] Excellent

   [/] Good

   [ ] Fair

   [ ] Poor

6. How would you rate the functionality of the system ?

   [ ] Excellent

   [/] Good

   [ ] Fair

   [ ] Poor

7. How does the links in the system facilitate your search/navigation in retrieving information ?

   [ ] Very Good

   [/] Good

   [ ] Fair

   [ ] Poor

8. Is the system easy-to-use (usability) ?

[x] Yes

[ ] No

9. Are the instructions in the WapFCSIT system clear and easy to understand ?

[x] Yes

[ ] No

10. Is the system response time acceptable ?

[ ] Fast

[x] Acceptable

[ ] Not so fast

11. Overall, are you satisfied with WapFCSIT system ?

[x] Yes

[ ] No

12. Give any suggestions or opinions to enhance the system requirements/needs.

This system should ~~be~~ also ~~can~~ be used widely not only for retrieving information in the faculty ~~but through overall UM~~ but also in gaining information about UM as well.

Thank you for your time!

GLOSSARY

3G (Third Generation)

3G mobile telephony gives you high-speed access, up to 2 Mbps (Megabits per second). This may enable live pictures, camera etc. on your phone. Preceeding 3G is analogue (1G). Then came GSM (2G). Currently GSM is now tested with GPRS (2.5G).

ADO

ADO or ActiveX Data Objects, provides an easy to use interface to the OLE DB.

ASP

Server-side scripting technology to make interactive web pages. Based on VBScript or JavaScript.

Card

In WML, a card is the page that is displayed to the user. A card must be contained in a WML deck.

Deck

In WML, a deck is the container for one or more cards. The deck provides necessary information about the document type, markup language and navigational templates for the cards incorporated in it.

DTD

A DTD (Document Type Definition) defines the names and contents of all elements that are permissible in a certain document. A DTD is used to specify XML document structure.

MICROBROWSER

A lightweight wireless Web browser found in mobile devices.

MIME

MIME is the short term of Multipurpose Internet Mail Extensions. MIME is a specification for formatting non-ASCII messages so that they can be sent over the Internet. Many e-mails clients now support MIME, which enables them to send and receive graphics, audio, and video files via the Internet Mail System. In addition, MIME supports messages in character sets other than ASCII. There are many predefined MIME types, such as GIF graphics files and PostScript files. It is also possible to define your own MIME types.

OLE DB

OLE DB is a component-based solution for accessing data from heterogeneous data stores.

PDA

Personal Digital Assistant is a palmtop computer with bundled personal organization applications.

SDK

Software development Kit provides a set of development tools for a particular technology.

SQL

Structured Query Language is an industry standard language for performing operations on relational databases.

UML

Unified Modeling Language is an industry standard object –oriented modeling language.

URL

Uniform Resource Locator locates a resource on the Internet that can be retrieved using the appropriate protocol.

WAP GATEWAY

A translating proxy that bridges the WAP and Internet worlds.

WML

Wireless Markup Language is an XML markup language for wireless devices.

XML

Extensible Markup Language is a World Wide Web Consortium (W3C) recommended standard for Internet markup languages.

REFERENCES

Arechart, C. *et al* (2000). *Professional WAP*. 1st ed. Wrox Publishers.

Bennet, C. (2001). *Practical WAP*. 1st ed. Cambridge University Publishers.

Deitel, H. M. *et al* (2002). *Internet & World Wide Web How To Program*. 2nd ed. Prentice Hall Publishers.

Deitel, H. M. *et al* (2002). *Wireless Internet & Mobile Business How To Program*. 1st ed. Prentice Hall Publishers.

Esposito, D. *et al* (2000). *Professional ASP Data Access*. 1st ed. Wrox Publishers.

Foo, Soo Mee *et al* (2001). *Dynamic WAP Application Development*. 1st ed. Manning Publishers.

Pfleeger, S. L. (2001). *Software Engineering Theory And Practice*. 2nd ed. Prentice Hall Publishers.

Sellapan, P. (2000). *Software Engineering Management & Methods*. 1st ed. Sejana Publishers.

Sellapan, P. (2000). *Systems Analysis & Design*. 1st ed. Sejana Publishers.

Scott, K. (2001). *UML Explained*. 1st ed. Addison-Wesley Publishers.

Whitten, J. L. *et al* (2001). *System Analysis & Design Methods*. 5th ed. McGraw-Hill Publishers.

Web URL :

Date retrieved : 20th of June 2002.

http://searchenginewatch.com/links/Specialty_Search_Engines/WAP_Search_Engines/

Date retrieved : 25th of June 2002.

http://www.w3schools.com/wap/

Date retrieved : 27th of June 2002.

http://www.wap-uk.com/Developers/Tutorial.htm

Date retrieved : 10th of July 2002.

http://www.thewirelessfaq.com/

Date retrieved : 11th of July 2002.

http://www.wapjag.com/

Date retrieved : 11th of July 2002.

http://www.gelon.net/

Date retrieved : 22nd of July 2002.

http://www.wapforum.org/

Date retrieved : 23rd of July 2002.

http://www.wapwarp.com/

Date retrieved : 25th of July 2002.

http://www.nokia.com/corporate/wap/sdk.html

Date retrieved : 5th of August 2002.

http://www.smartdraw.com/

Date retrieved : 10th of September 2002.

http://developer.openwave.com/download/license_41.html

Date retrieved : 11th of September 2002.

http://java.sun.com/j2se/1.3/jre/

Date retrieved : 10th of October 2002.

http://www.123wapinfo.com/scode/asp/

Date retrieved : 2nd of Disember 2002.

http://www.testpros.com/testingservices/e_commerce/waptestfunc.asp

Date retrieved : 28th Disember 2002.

http://mcsl.mampu.gov.my/english/s_public2002.htm