WEATHER INFORMATION SYSTEM FOR FARMERS BASED ON WAP TECHNOLOGY

A thesis submitted to the Faculty of Information Technology
In partial fulfillment of the requirement for the degree
Master of Science (Information Technology)
Universiti Utara Malaysia

By
Abdullatif Abdullah Ahmed Abolohom

PERMISSION TO USE

In presenting this thesis in partial fulfillment of the requirements for a postgraduate degree from Universiti Utara Malaysia, I agree that the University Library may make it freely available for inspection. I further agree that permission for copying of this thesis in any manner, in whole or in part, for scholarly purpose may be granted by my supervisor(s) or, in their absence by the Dean of Research and Post Graduate Studies. It is understood that any copying or publication or use of this thesis or parts thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and to Universiti Utara Malaysia for any scholarly use which may be made of any material from my thesis.

Requests for permission to copy or to make other use of materials in this thesis, in whole or in part, should be addressed to

Dean of Research and Post Graduate Studies
College of Arts and Sciences
Universiti Utara Malaysia
06010 UUM Sintok
Kedah Darul Aman.

ABSTRACT

The WAP application is an application that is accessed via mobile device over a wireless network; this technology has been rapidly growing and distributed in different environments and has basically affected our lives directly and indirectly. This study carried out an investigation into the Weather Information System for Farmers based on WAP Technology to simplify the weather queries via the mobile device. Furthermore the proposed application would be able to save the time and effort of the farmers in checking the required weather changes. The WAP Weather Information System was developed based on WML and ASP mobile programming architecture; furthermore, the usability testing results were obtained to determine the system usefulness. Finally, the WAP Weather Information System may help the farmers by providing them with useful functions, such as weather news, product price, and local news.

ACKNOWLEDGEMENT

By the Name of Allah, the Most Gracious and the Most Merciful

First, I would like to express my appreciation to Allah, the Most Merciful and, the Most Compassionate who has granted me the ability and willing to start and complete this study. I do pray to His Greatness to inspire and enable me to continue the work for the benefits of humanity.

My most profound thankfulness goes to my supervisor Dr. Mohd Syazwan Bin Abdullah for his scientifically proven and creativity encouraging guidance. Honestly, he has been all the time center of inspiration and guidance. I'm gratefully and deeply thank him for his support and cooperation as being equipped to provide his best help. My thanks also go to Dr.Tareg Abolohom and my uncle Eng. Taleb Alsabri who have supported and encouraged me the ability and willing to complete this study . "May Allah bless all of them"

Last but not least, I wish to thank all my dearest family members, especially my Father, my Mother, and my lovely Brothers and Sisters. I dedicate my admiration and thanks to all of them who have sacrificed their selves and supported me to the completion of the thesis. My demonstrative appreciations are to all my friends, my colleagues, all FTM staff, and everyone who has put the hand either directly or indirectly to complete this thesis.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

1

This chapter briefly presents the main idea of this work, detailing the questions and main elements involved in the study. The first sub-topic describes the overall idea in this study through the scenario and the introduction that lead to the implementation of the whole project. This is followed by the problem statement, objectives of the study, scope of the study, and significance of the study. The final section elaborates the way this report is organised.

1.0 Introduction

The purpose of Wireless Application Protocol (WAP) was designed to facilitate the manufacturers, vendors, and technology users around the world to independently access the Internet and advanced telephony services (Elalfy, 2005). WAP technology is capable of eliminating the gap between mobile devices and the Internet, and thus can provide and cater for mobile services.

In the context of the agricultural farmers in Kedah, they normally go to their plantations with minimum technology capability without knowing the weather status and changes. Moreover, different studies have illustrated the impact of weather changes on the farmer's performance and ultimately output. The WAP

technology today can help these farmers to overcome these situations by providing a flexible application of farming weather information delivered to them, which is defined by the International Engineering Consortium as an application environment and set of communication protocols for wireless devices to communicate with each other and with any external application.

This study was performed to study the requirements to develop such a WAP application to help farmers to improve their production output by having prior information to face or prepare for the weather changes.

1.1 Problem Statement

Weather changes affect the life of the farmers in the rural areas. These changes may bring many difficulties for them. For example, most of the farmers in rural areas live in different places from their farms, some of them near and some far away from their farms, which would make it hard for those farmers to go back and forth during the sudden changes in the weather state. Hence, they are sometimes forced to return to their homes prematurely without being able to complete their work on the farm.

In order to address this problem, these farmers would have to enquire about the weather changes, by using the Telecentres (TC) that provide weather information for the rural areas. It is hard for them to visit these Telecentres (TC) everyday to

ask about the weather. Furthermore, some ICT facilities are unable to access the more remote areas without having to incur large cost.

Therefore, this study has attempted to alleviate this problem through an appropriate mobile application to provide the farmers with the weather details and changes.

1.2 Objective

This study has illustrated the importance of WAP technology in providing the weather condition for farmers. The objectives of this study are:

- to identify the farmer requirements for determining the weather conditions based on WAP technology, and
- to develop a WAP application for farmers to determine the weather condition.

1.3 Scope of Research

The research scope is to supply the farmers with the appropriate details about the weather states by using a WAP application, so that they can enquire about the weather conditions anytime and anywhere. This study will support the farmers to view the weather details via their mobile devices to make them able to determine the weather changes.

1.4 Research Significance

This research would contribute by improving the current query system for farmers to check the weather conditions, in other words a weather information system that would be useful for farmers. The proposed application will give the opportunity to these farmers who are not close to TCs or other facilities, such as (television, radio, etc.) to check the weather conditions.

1.5 Organisation of Thesis Report

This thesis report is presented in six chapters, which was initiated with the introduction in the first chapter. The remaining chapters include the literature review, methodology, findings, and conclusion, more of which will be explained in the following.

The second chapter presents the literature review that is related to the study. It reviews the previous and current application of weather information systems for farmers, as well as any possible on-going projects which have implemented their application on mobile devices. The literature review also gives some insight of applications of WAP technology that have been or are being used in real life.

The third chapter presents and explains on the methodology that was used in the study, which is the main part of the whole project. All the processes of developing the system is presented in the fourth chapter which includes all related diagrams

for the purpose of development, such as use case, class diagram, object diagram, sequence diagram, and others.

This chapter will also show the user interface of the weather information system for farmers, as well as the functions available.

Then, chapter five discusses the study as a whole, according to the results and findings obtained from the previous chapter. The chapter also provides suggestions for future work.

1.6 Summary

WAP application grows to be more accepted because of its accessibility from anywhere. The proposed WAP weather information system for farmers is a WAP-based application that can be used to keep track of weather changes. The farmers can easily access the required weather pages using hand-held devices, which will be a useful tool for that purpose, and become a valuable component for other applications. The main benefit of the system is its potential to provide greater convenience and greater accessibility. The WPESS has demonstrated its abilities of being able to provide easy access for the farmers to view relevant information from anywhere, anytime. The proposed mobile application enables farmers to check the weather state with a simple user interface and useful links.

[redacted]

This chapter presents the literature review on the area of related interest during the period of study. It conceptually gives an insight and reviews on the previous and existing work that have been conducted on the same area. According to the title of the project, this chapter is organised in three sections. The first section presents an introduction about the usefulness of WAP technology, and also, an overview about the Malaysian agricultural farmers. Meanwhile, the second topic will shed light on the technology of Wireless Application Protocol (WAP), and the third reviews the Wireless Markup Language (WML), which is the main markup language applied to program the mobile weather guide. In addition to that, the last section reviews the related work related to mobile application.

2.0 Introduction

There is a wide range and the useful utilisation of the WAP application handset in both urban and rural areas, which can deal with most facilities, e.g. television, satellite, desktop, laptop, and Internet. The mobile device in many towns and places may contribute to enhance and develop the business transaction. The mobile phone has become the most important tool that is used in the rural

community; the mobile device can present users with some useful facilities to use, more than just to exchange pleasantries by messages. Additional uses of these mobile devices by the rural residents include many applications in many fields, such as reading the local news, health care, cases of weather, and many other things, but this is still not fully utilised by the rural community (Yakasai, 2008; Erlandson & Ocklind, 1998).

Mobile phones are a usable solution in the rural community because the majority of them use this device, like the mobile phone, and computers and connection to the Internet are perhaps not available in or not affordable by the rural community. This is because of the large distance for these areas that make it hard for the government to provide the appropriate structural facilities for accessing these technologies in these areas.

The new integration for the mobile application makes it easier for the people in the rural areas by managing information and providing local information through the mobile screen. A new mobile feature, such as information query, would enable the farmers in rural communities to close the gap between the main cities and rural areas and the world, which would only benefit by building linkages with these villages. Mobile agents can collect data and provide services as a common strategy to offer to the rural community (Parikh & Lazowska, 2006; U.S. Agency for International Development, 2005).

2.1 What Does Farmer Mean?

According to (IFAP) (2008), the main definition for a farmer is someone with an ownership interest, and the farmers are able to provide land or management in their production. However, most of those farmers can provide only labour are called farmhands. However, Malaysian farmers have been identified as being the majority in different rural areas. In other words, farmers are often members of local, regional, or national farmers' unions or agricultural producers' organisations. Agricultural producers, small and large, are represented globally through the International Federation of Agriculture Producers (IFAP). Farming activities are very much dependent on weather.

Malaysian farmers, in the context of developing nations or other pre-industrial cultures, have practised meagre subsistence agriculture in a simple organic farming system, employing crop rotation, slash, and burn or other techniques to maximise efficiency while meeting the needs of the household or community, using saved seed which is native to the eco-region. In developed nations however, Malaysian farmers' use of such techniques on small patches of land might be called a gardener and be considered a hobbyist. Alternatively, one may be driven into such methods by poverty or, ironically, against the background of large-scale agri-business which may become organic farmers growing for discerning consumers in the local food market.

2.1.1 Rural Communities

Rural is an adjective that identifies the people who live in these areas, the places and the things that need to use in these areas; in other words, it is the life outside of built-up areas or the city (Rural communities, 2008; Yakasai, 2008). This is also to say that rural is defined as a county outside of a metropolitan area, or a county inside a metropolitan area that has no urbanised population (The Rural Housing Data Portal, 2008).

Thus, communities can be defined as the people living in an area, which can also mean the area itself, otherwise the communities can be defined as a group of people with common interests, especially when living (Bhavnani, 2008).

Urban means the opposite of rural, meaning the areas which are metropolitan and also built-up, like cities and townships.

2.1.2 Technology and Farmers

Most of the Malaysian population in rural areas is subsistence farmers who have little or no access to new technology and markets for their produce. Access to water for irrigation and the news are one of the most critical constraints that small farmers face, in different Malaysian areas, where farmers unable to track the weather changes during their work. Effective and modern systems for providing these facilities have a high initial cost that most small farmers could not afford, leaving many unable to grow enough produce even to feed themselves and their

families. Agricultural opportunities and farming systems are also influenced by a host of other factors, including, especially, access to science and technology, government policies, market and land tenure institutions, development of human capital, and local organisational development

2.1.3 Farmers and Weather

The weather in Malaysia is mainly influenced by two monsoon regimes, namely, the southwest monsoon from late May to September, and the northeast monsoon from November to March. The northeast monsoon brings heavy rainfall, particularly to the east coast states of Peninsular Malaysia and western Sarawak, whereas the southwest monsoon normally signifies relatively drier weather. In the past, widespread floods have occurred especially during the northeast monsoon season. Malaysia has always been complacent and perceived to be relatively free from major hydro-meteorological and geological hazards. The last decade has seen a change in the occurrence of natural disasters in the country. With rapid development in high-rise buildings and other infrastructures, the occurrences of hydro-meteorological and geological hazards have increased. These natural hazards include monsoon flood, flash flood in the cities, severe storms, storm surge, landslides, earthquakes, and tsunamis.

Most rural villages in the developing world do not have the economy or infrastructure required to support computers of other facilities to provide them with their queries about the news, weather information, and other details.

Therefore, the farmers in these rural areas must travel to larger cities to access digital resources. In these rural areas, the weather change effects the product quality and the productivity of those farmers who work the land. Hence, this imposes severe limitations on the aggregation and dissemination of information; recent advances in mobile phone computing capabilities make this device a better candidate for this type of community. Long battery life, wireless connectivity, and low price, all these characteristics make it the more appropriate device in rural conditions better than a Personal Computer (PC) (Parikh & Lazowska, 2006).

2.2 WAP (Wireless Application Protocol) Definition and Overview

The emerging technology behind M-Commerce is based on the Wireless Application Protocol (WAP). It is a new technology that links wireless devices to the Internet (Polylab, 1998). WAP is a specification for a set of communication protocols to standardise the way that wireless devices, such as cellular telephones, can be used for Internet access, including e-mail, the World Wide Web, newsgroups, and instant messaging (Mobile Computing WAP, 2005; WAP, 2008; Hulberts, 1989).

In 2000, Jukka Lieslehto referred to the term WAP as a protocol that enables information transfer between servers connected to computer networks and wireless devices (Imulienski, & Badrinath, 2001). The protocol specifies how the communication between mobile phones and other wireless terminals, wireless networks, WAP gateways, computer networks, and web application servers occur

with each other. According to him, the Wireless Application Protocol (WAP) is supported by some new mobile phones in the market these days and the implementation of the WAP technology makes it possible to deliver web applications over the wireless telephone network (Jagoe, 2003).

The motivation of defining the specification for wireless communication network had relatively relied on the market situation of wireless application, which is growing very quickly and reaching new customers and services over time. In order to assist operators and manufacturers to meet the challenges in advanced and flexible services creation, WAP has defined a set of protocols in transport, session, and application layers (Kendall, 1996). The protocols are largely based on Internet technologies. Above all, the reason for developing wireless applications and its protocols was to extend Internet technologies to wireless networks, bearers, and devices (WAP Forum, 2002).

Referring to the Wireless Application Protocol White Paper (2002), it was estimated that there will be more than 530 million wireless subscribers by 2003 (Nielsen, & Landauer, 2001). Later on, new estimates were reported, where the number of wireless subscribers would break the one billion mark by 2004. In the same year, it was also estimated that the mobile phones available in the market will have multimedia capabilities which include the ability to retrieve e-mail, and push and pull information from the Internet. This shows how WAP application is

an emerging and fast growing technology which has to be looked into deeper (Wireless Application Protocol Forum, 1998).

2.2.1 Characteristics of Mobile

Elliott and Phillips (2004) explained that mobile devices are small handheld devices such as mobile phones, palmtop computers, and devices which a special operating system. Mobile devices also include Personal Digital Assistants (PDAs) with or without networking capabilities and mobile phones that may or may not be able to access the web. Handheld computers are mobile, flexible devices that can provide real-time, one-to-one support for students from within the context of their learning activities (Tung et al., 2007). In general, the characteristics of mobile devices convergence of mobile, handheld, and wireless communication technologies are the newest technological revolution.

2.2.2 The Rapid Growth of the Mobile Phone

Mobile applications increasingly affect business activities and information distribution. They are gaining wide acceptance due to the increased need to support the mobile workforce and rapid enhancement in wireless communication devices and technologies. Many applications allow sending and viewing e-mail, browsing the World Wide Web, viewing traffic and weather reports, watching movies, and accessing back-end database systems (Elalfy, 2005).

Table 2.1*:* Hand phone users by urban and rural sector in Malaysia (MCMC, 2007)

Sector	2005	2006	2007
Urban	81.9	80.5	78.0
Rural	18.1	19.5	22.0

According to Table 2.1 above, the percentages showed that the usage of mobile devices in the rural areas of Malaysia shows an increasing trend, which increased from 18.1 in 2005 to 22.0 in 2007 (MCMC, 2007).

The large progress of affordability and the access to mobile phones in all world communities has occurred (Kray, & Baus, 2003; Petra Blixt, 2005), and thus more individuals in rural sectors are able to became more familiar with this new technology. There are facts that need to be determined during the increase of usage of the mobile devices in Malaysia such as:

- Affordability (Demand-Side): The mobile devices offer affordability and choice, even for very low-income customers.
- Affordability (Supply-Side): Establishing mobile masts and turrets is a relatively inexpensive way of serving large and remote rural areas, comparing with fixed-line telephony.

- Flexibility: Mobile devices can be used for many facilities, which support the user for sending message, voice, video, and WAP applications (more flexible than radio/TV).
- Low Barriers to Entry: The mobile device has become, in this day, the most effective and easily accessible for the external and internal use in the rural areas. The low cost of buying these devices by the user make it more flexible to have these devices in these areas, even in the poor areas (Bhavnani et al., 2008).

Table 2.2: Hand Phone users by nationality in Malaysia

Nationality	2005	2006	2007
Malaysian	93.7	92.5	90.3
Non-Malaysian	6.3	7.5	9.7

Table 2.3: Hand phone users by gender in Malaysia

Gender	2005	2006	2007
Male	57.4	58.3	56.4
Female	42.6	41.7	43.6

According to the tables above, around 90% of Malaysian people use the mobile device, and around 9.7% non-Malaysians use the mobile device. This can be classified into two different parts; around 54.4% are males who use the mobile device, and around 43.6% are females.

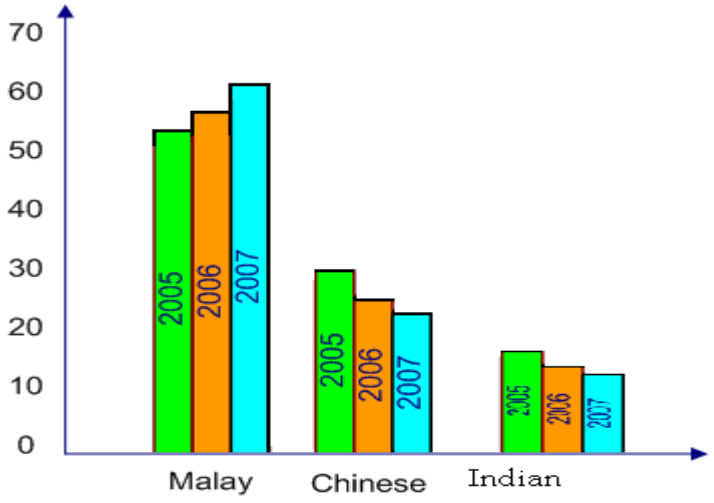


Figure 2.1: Hand phone users by ethnicity.

Table 2.4*:* Hand phone users by ethnicity

Ethnicity	2005	2006	2007
Malay	53.9	57.3	61.1
Chinese	32.4	28.9	25.8
Indian & Others	13.7	14.8	14.1

The success of today's information age society depends on the individual's ability to retrieve the appropriate information, communities, and businesses fields in the rural communities, thus the WAP application in these fields is appropriate.

According to the table above, the Malays are the largest of users accounting for 61.1%, Chinese 25.8%, and 14.1% for Indians & others.

According to the diagram above, it shows the increasing trend of using the mobile device, which leads us to ability of the mobile devices for the developing of these communities through the implementation of new applications, such as mobile banking services, access to the Internet, and local news applications channelled through mobile devices, especially in the rural communities

2.3 Wireless Markup Language

According to Tetard & Patokorpi (2004), and Imulienski & Badrinath (2001), displaying published content from the wireless web in mobile pervasive devices has once been seen as a challenging effort. This was due to the several limitations of these devices which include the limitation of small screens available on most cellular phones and PDAs. For that reason, Wireless Application Protocol (WAP) has defined a new format, the Wireless Markup Language (WML) for the purpose of content delivery from the wireless web to the wireless pervasive devices. Meanwhile, according to a source of information retrieved from Soohoo (1997) and Lieslehto, (2000), WML is a markup language which is specially designed for specifying and displaying content on WAP devices. It is similar to the use of HTML in developing webpages, only that it is purposely created for implementation of web-like application in wireless devices.

However, with the constraints of small narrowband devices, the WML was specifically implemented to facilitate in specifying content and user interface of

the applications in these devices. The constraints of these kinds of devices include:

- small display and limited user input facilities,
- narrowband network connection, and
- limited memory and computational resources.

Based on the Wireless Application Protocol Forum (1999), WML is a markup language which was originally based on the Extension Markup Language (XML). XML is a markup language that allows the organisation of information that is easily understandable by humans and computers for the communication between these two entities in a wireless application. XML is a markup language designed to specify and describe structured data on the Internet. Structured data over the Internet such as invoices, financial spreadsheets, product descriptions, bills, and balance sheets cannot be controlled directly but have to be specified by a markup language. Thus XML becomes one of the most common markup language for specifying the syntax and semantics of messages exchanged between computerised entities. Referring back to the concept of WML, WAP Forum (1999) stated that WML includes four major functional areas, as follows:

- Text presentation and layout
  - Text presentation and layout determination in WML applications involve organisation of all text elements in the application including images. This

also involves various formatting and layout commands, such as boldfaced text, paragraph indention, and etc.

- Deck/card organisational metaphor
  - In the implementation of WML, all data and information are organised into a collection of cards and decks. The Card is a specification of one or more user computer interaction frames, while a deck is the unit of content transmission and it is similar to a HTML page. Cards are grouped together into Decks and identified by the Uniform Resource Locator (URL).

- Inter-card navigation and linking
  - In developing wireless applications, WML has the ability to control and manage navigation between cards and decks. Among others, for the purpose of navigational and execution of scripts, WML also provides the provisions for event handling in the mobile devices and support the functions of anchored link.

- String parameterisation and state management
  - Using a state model, all decks in WML can be parameterised where all variables can be used as a substitute of strings. This substitution can happen at run-time. The purpose of parameterisation is to make sure that the network resources are used efficiently.

By focusing on all of the areas of functions, WML is able to facilitate in the development of wireless application by referring to the architecture of WAP technology, which is basically organised in a layered form. These layers represent the protocol and application environment which should be followed in order to make sure that the application developed will meet the requirements for wireless application, taking into consideration the integration with wireless or mobile devices.

As mentioned in the prior discussion, WML is designed with the intention to overcome the constraints of small and narrowband devices. These constraints in this kind of communication devices put limitations on it and make it unavailable for several purposes. The limitations of these WAP devices are described in four characteristics as follows:

- Narrowband network connectivity
  - Mobile devices are commonly equipped with 300bps to 10kbps network connections. This characteristic may result in a latency period of up to 5-10 seconds for a round trip.

It is stated above that WML is based on XML, which is derived from xHTML, and xHTML is the XML version of HTML. Despite the fact that xHTML is the XML version of HTML, there are many differences between these two

application development tools. Among others, the differences can be listed as follows:

1. WML has a different mechanism for linking between its pages called “cards” while HTML uses the hyperlink command language to make links to text, graphics pages, and etc.
2. WML browsers are very sensitive to errors compared to HTML browsers by not being tolerant of any errors that occur.
3. In WML browsers, the closing tags have to be matched and meet the predefined requirements, in line with the characteristics of XML.
4. WML works with the WAP micro-browsers found on WAP devices while HTML is run over the Internet using normal browsers.

2.4 Mobile Application

According to Barbara (1999), Dunham (1995), and Imielinski and Badrinath (1994), these days the mobile device is rapidly growing and spreading their application areas; the useful application and the attractive services that could help to support human activities in the outdoor environment is one of the principal applications of mobile computing.

According to Sommerville (2001) and Bhattacharyya (1997), a study may preset the mobile transportation to determine the user location by using some function to calculate the user destination and map the current user location. This function is very useful for visually or aurally handicapped passengers because the guide

information is given by visual or voice messages in the public transport, but these passengers cannot use some of them (Goto & Kambayashi, 2002).

Mobile guides are the result of years of research in the areas of recommenders, ambient intelligence, and pervasive computing. Cyber guide (Abowd et al., 1997) was one of the first mobile guides. Personal preferences are not analysed to compute a tour plan but the user can retrieve information or request a route to a desired Point of Interest (PoI). GUIDE (Cheverst, 2000) is a mobile guide very similar to the hereby presented Dynamic Guide (DTG) (Kramer, 2005).

The user is able to choose attractions from various categories. These attractions are then sequenced while taking into account the opening hours, best time to visit, and the distance between attractions. The sequence can be modified manually. Navigation is achieved by a map with a list of instructions. Differences to the DTG are the use of cell-based positioning instead of GPS, and the selection of concrete sights instead of deriving the selection from generic preferences.

2.5 Conclusion

The introduction and the main features presented in this chapter was to provide the reader with the highlight on the aim of this research, and also this chapter has discussed the related literature review to the issue of mobile technologies and its applications in the other fields in Malaysia and other countries. This presentation

has provided support for the application of mobile news services in the rural communities.

The Waterfall methodology, which was adapted by Kothari (1985), is used in order to achieve the objectives stated out previously, as discussed in the next chapter. This methodology has been carefully chosen to make sure that it is suitable for developing the proposed application; the reasons back of choosing this methodology are; (a) appropriate for application development, (b) provide researchers with the user requirements for building any application, (c) analyse, design, develop, and evaluate these requirements.

3

This third chapter gives an overview and describes the details of the Waterfall methodology that was used in this study project. This methodology has been adapted for the development of the WAP application information system for farmers. In the following subtopics or sections, all phases of the methodology are discussed accordingly, with reference to the case of project.

3.0 Introduction

The meaning of research methodology is more than just a collection of methods to perform a research. It is a systematic way to solve the research problem (Kothari, 1985). The research methods refer to the methods and techniques used by the researcher in performing the research, for example data collection techniques, data processing techniques, and instruments. Based on the fact that the research objective is to develop a software solution, the research methodology adopted for this project is the Waterfall methodology, for guiding the development of that solution. This section discusses the Waterfall methodology which was adopted in this study to achieve the study objectives. This methodology consists of five phases as shown in Figure 3.1.

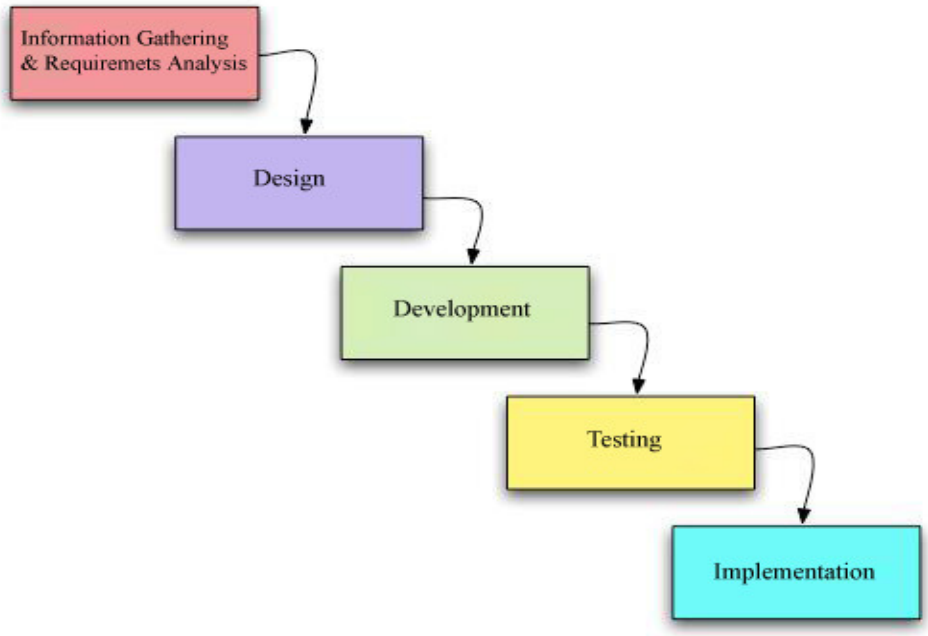


Figure 3.1: Waterfall Methodology (Kothari, 1985)

3.1 Information Gathering and Requirements Analysis Phase

To come out with the objective of this research, there is a need to understand the research domain first, which is a weather information system for farmers. The process started by getting information about the functions of weather system in general. It is necessary to identify what the farmers need in order to create an application that is able to solve or at least reduce their problems. In this stage, a use case was drawn using the Unified Modeling Language (UML). UML is used to show the requirements gathered (Whitten, 2001).

3.2 Design Phase

The design serves as a blueprint for the system and helps detect problems before these errors or problems become built into the final system. In the design phase, the research would determine the necessary specifications for the hardware, software, people, and data resources, and the information products that will satisfy the functional requirements of the proposed system (Davis, 1989). Sequence diagrams will be used in this stage. The object-oriented method offers conceptual structures of the system to assist in understanding the whole system's functions, especially during implementation or writing programs. The research would produce use cases to represent the whole functions available in the mobile application. In addition to this, the sequence diagram is also generated to visualise the structure of the system flows. All of these diagrams were produced using the Rational Rose Enterprise Edition software.

3.2.1 Logical Design

Hoffer et al. (1999) explained that logical design is the phase where all functional features that have been chosen for the development of the system are described without regard of any computer platform. Assuming that the developed system could be implemented on any hardware or systems software, the aim of this phase is actually to make sure that the system can really function as it should be. This also involves the representation of functional requirements of the system in the form of notation, which in the case of this study, the object-oriented approach adopted by the researcher. The adoption of this approach is in line with the need

to produce a more detailed design, besides the increasingly complex system requirements (Bahrami, 1999).

The object-oriented approach offers conceptual structures of the system to assist in understanding the whole system's functions, especially during implementation or writing programs. For this project, Unified Modeling Language (UML) was used as the technique of notation to represent the system's requirements. With UML, the researcher had produced use case diagrams to represent the whole functions available in the WAP application information system for farmers. Other than that, the sequence diagram was also generated to visualise the structure of the system flows.

3.2.2 Physical Design

Meanwhile, physical design deals with the process of converting the logical design into a more technical specification of the system development. In designing the physical part of the system, all diagrams of data sources, data flows, and data processing that was produced in the logical design was turned into a structured systems design. During physical design, the researcher had identified and chosen which programming language and database system to be used, as well as the determination of which hardware platform, operating system, and network environment the system will run under. The specifications are as follows:

Table 3.1: H/W.S/W Specifications

Purpose	**H/W.S/W Requirements**
Programming Language	Wireless Mark-Up Language (WML)
Operating System	Microsoft Windows Operating System (Win95/Win98,Windows2000,WindowsME, Windows XP)
Hardware	Monitor, CPU, RAM (16MB and above), Disk Space (minimum 12MB)

The programming part of the project was dependent on the result from the designing process, which include the system's functions, entities involve, hardware and operating system determined. After everything was designed, the physical system specifications were ready to be turned over to programmers for the next phase, which is the implementation phase.

3.3 Development Phase

This phase is sometimes called coding and debugging. It is the main phase of the development cycle because during this phase the process of creating the final system will be done. The research focused more on identifying the system component and defines the relationship among them. The output from the design phase is used to develop the system. In this phase ASP and WML were used to design the final system.

3.4 Testing Phase

In this phase, the system was tested by different users selected from the rural area population in Kedah. The users were given an opportunity to use the system. Comments and suggestions were given to the developers in case of any problems or bugs that showed up during this phase.

3.5 Implementation Phase

This is the final phase of the project. After testing, the system was developed in its real environment. Once the weather information system for farmers had been tested satisfactorily, it is delivered and installed for use by farmers. The introduction of the weather information system for farmers has to be managed carefully so as not to cause unnecessary disruption and to minimise the risk of change.

Table 3.2: Software Specifications

Purpose	**Software/Platform**
Writing WML codes	WAPTOR
Rendering WML codes	Microsoft Mobile Emulator (MME)
Rendering WML files	Open Wave
Creating and modifying images	Adobe Photoshop 6.0

As proposed by Hoffer et al. (1999), the implementation phase consists of all those processes stated by Kendall (1996). However, Hoffer and his friend did cite some other relevant processes which are documentation, training, and support.

3.6 Summary

As a summary, the Waterfall methodology has been carefully chosen in order to develop the proposed WAP application for this study. The sequences of the five steps in the general methodology for carrying out the mobile weather information system were discussed. In the next chapter, the system and testing of the proposed system will be discussed.

In the previous chapter, the methodology of project that was applied in this research has been described. The methodology consists of five phases which includes planning and selection of project, analysis, design, implementation, and documentation. Later in this chapter, the middle phase, which is analysis and design phase with the last phase being the implementation, will be discussed in a more detailed elaboration. Among others, it explains the requirements determination and structuring activity, as well as the production of the system design according to the identified functional requirements.

4.0 Functional Requirements

- This application helps the farmers in viewing the weather details via WAP technology, which provides the farmers with an easy and flexible way to check the weather status.
- This application supports the farmers in viewing the product price details, such as product name and product price.

- This application supports the farmers in viewing the farm news via mobile device.
- The proposed application provides the farmers with the username and password for login process; farmers will be able to use the proposed application using correct username and password (Bahrami, 1999).
- The database contains all the information about the login information.
- The farmers are able to select the current day to view the selected day details.

4.1 Non-Functional Requirements

1) **Security:**
    - Unauthorised individuals may not use the application, just view the main page.
    - The farmer must not be repeated in the same group.
    - The application cannot enter unauthorised pages for them.
2) **Usability:**
    - The application must be easy to deal with.
3) **Understandability:**
    - The application should be easy to understand.
4) **Reliability:**
    - The application should present the same selected sequence.

5) **Performance:**

- The application must have reasonable speed according to the technology used.

6) **Availability:**

- The application should be available to all kinds of farmers.

4.2 Requirements to Design Weather Information System for Farmers

This application was developed using several tools and techniques. As shown in Table 4.1, a description of the requirements for the mobile application design is given.

Table 4.1: List of software

Purpose	H/W.S/W Requirements
Programming Language	Wireless Mark-Up Language (WML)
Operating System	Microsoft Windows Operating System (Win95/Win98,Windows2000,WindowsME, Windows XP)
Hardware	Monitor, CPU, RAM (16MB and above), Disk Space (minimum 12MB)

4.3 Use Case Diagram

According to the use case diagram in Figure 4.1, the proposed application represents the farmers as the main user; the farmers in the proposed application

must login via his or her username and password to view the application pages. Farmers are able to view weather news, product price and local news, as well as view the current daily news by the selected day.

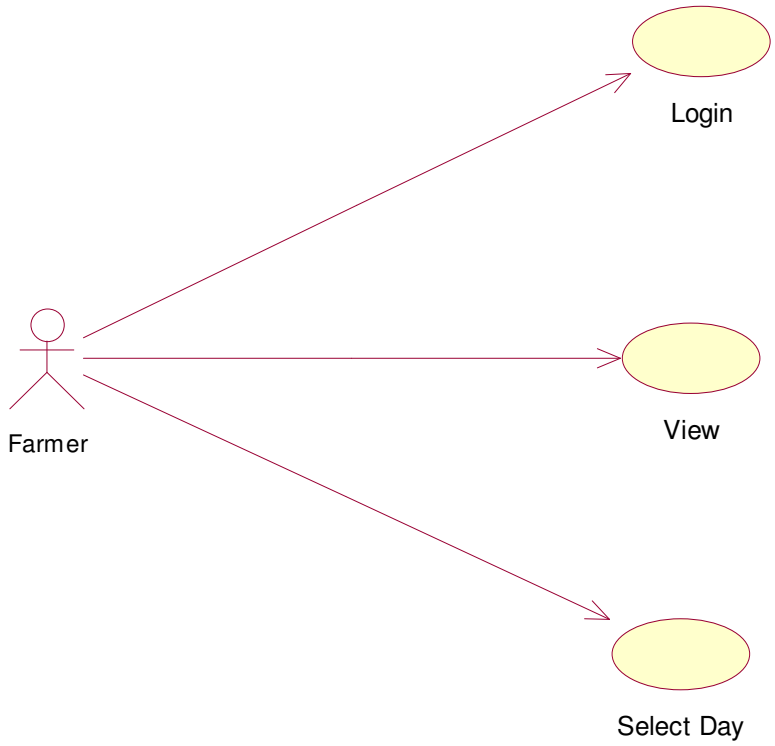


Figure 4.1: Use Case Diagram for WAP Weather Information System for Farmers

4.4 Identifying Use Cases

Use cases represent sequences of actions carried out by the system, and actors represent the people or other systems that interact with the system being modelled. Use case diagrams are supported by behaviour specifications, which define the interaction within a particular use case (Bennett et al., 2002; Dennis et al., 2005) by identifying the system, visiting some sites, and talking to some

related people to cover the system behaviour. The required use cases used in this system by the farmers are:

- Login
- View
- Select Day

The Use Case Identification for All the Users:

1) **Use Cases for the Farmers:**
   - Login
   - View
   - Select Day

4.5 Use Case Specification

4.5.1 Login

Login User
Actor: - Farmer.
Brief description: In this use case, the farmer shall login using his or her user name and password to enter the proposed application, and to start the operations.
Basic flow: 1. The farmer will enter his user name and password. 2. The login will be checked by the system. 3. The system will respond to the login by showing a corresponding page to the farmer.
Alternative flow: 1. If the farmer entered either his user name or password incorrectly, the system will alert him to re-enter the correct information. 2. If the farmer did not enter a user name or password, the system will alert him to fill the login fields.
Pre-condition: Enter the user name and password for farmer.

Post condition: 1. If the login is successful for the farmer, the application main page will be shown to him. 2. In case of invalid user name or password, a message should be shown to alert him. 3. In case of null user name, a message should be shown to alert him for not entering.

Table 4.2: Use Case Specification for Login Use Case

4.5.2 View

View
Actors: Farmer
Brief description: In this case, the farmer is able to view different choices that the proposed application supports.
Basic flow: 1. Select view of weather news, product price, and local news. 2. The application will respond and show the chosen pages
Alternative flow: The farmer can leave it without viewing.

Pre-condition: Press view
Post condition: 1. The farmer views the weather details. 2. The farmer views the price of products. 3. The farmer views the local news.

Table 4.3: Use Case Specification for View Use Case

4.5.3 Select Day

Select Day
Actor: - Farmer
Brief description: This use case provides the farmer a view of the current day details from the day list.
Basic flow: 1. The farmer presses select day 2. The farmer chooses the current day 3. The farmer presses OK 4. The system will response to the farmer request by showing a corresponding page to the farmer

Alternative flow: Not applicable
Pre-condition: 1. Press select day 2. Chose day
Post condition: 1. View the selected day details

Table 4.4: Use Case Specification for Select Day Use Case

4.6 Sequence Diagram and Collaboration Diagram

The sequence diagram is a UML diagram that shows the processes that execute in sequence; the sequence diagram shows the sequence of message (Atle, 2008; Schmuller, 2002), which are exchanged among roles that implement the behaviour of the system arranged according to time (Jacobson, 2004). It shows the flow of control across many objects that collaborate in the context of a scenario (Eriksson, & Penker, 1998; Hoffer et al., 2002; Hoffer et al., 1999; Silva, 2003).

The sequence diagram (interaction) captures the behaviour of a single use case showing the messages passed between those objects of the case and describes the sequence of operation in that use case (U.S., 1999; Atanas & Miriam, 2006).

There are three kinds of objects:

- Boundary: it is the boundary of the user and its actors (interface).
- Entity: it is the information a system uses (date).
- Control: it is the control logic of the system (who does what).

4.6.1 Sequence Diagram for Login Use Case

This sequence diagram is initialised by farmers during login to their weather information system pages, where the farmer is required to insert the correct username and password.

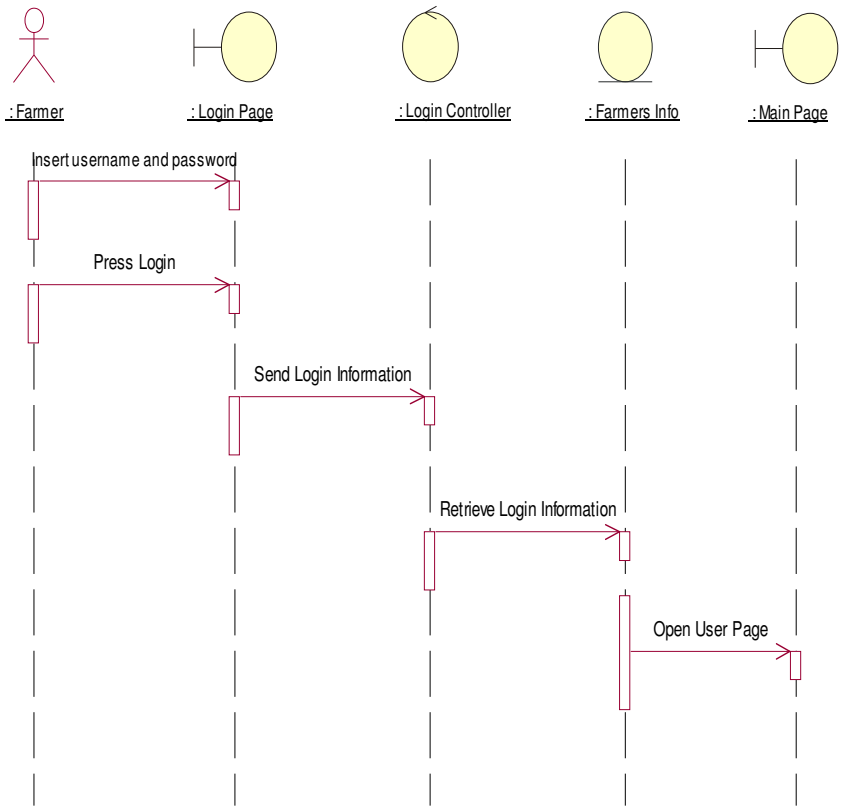


Figure 4.2: Login Sequence Diagram

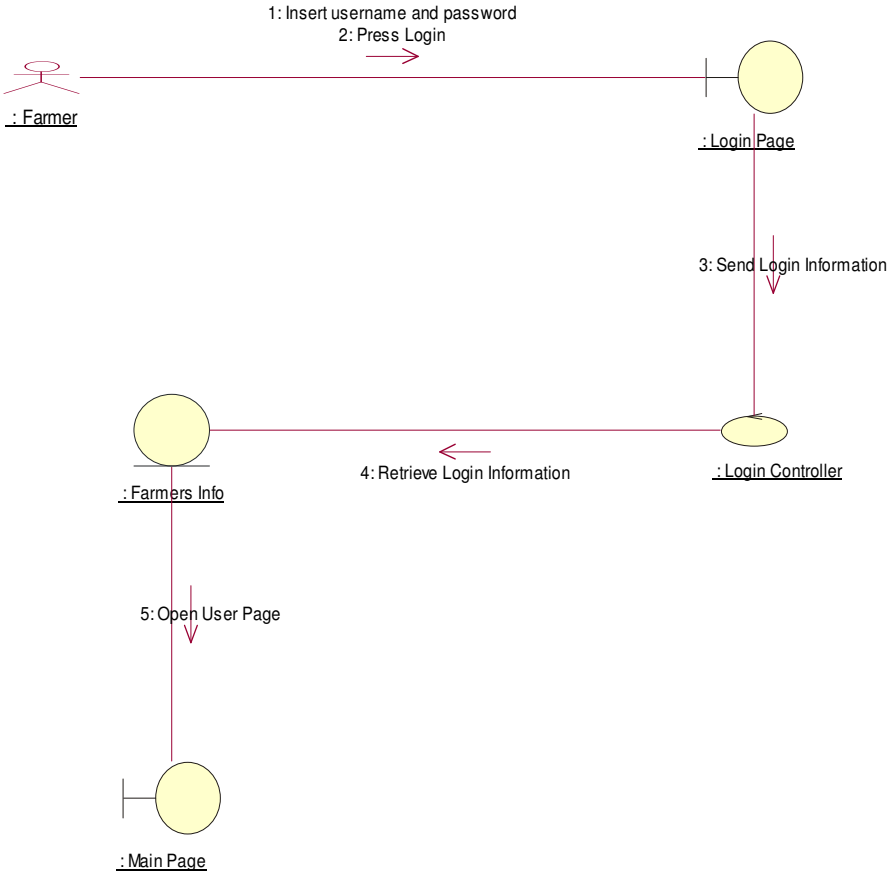


Figure 4.3: Login Collaboration Diagram

4.6.2 Sequence Diagram for View Use Case

This sequence diagram is initialised by farmers to view the weather status after the correct login.

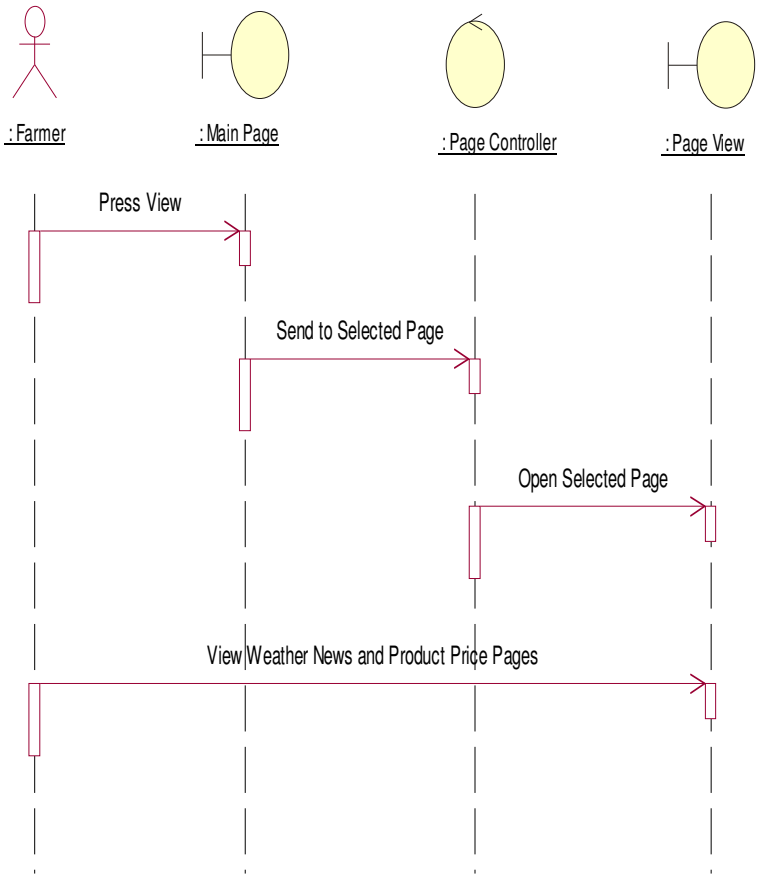


Figure 4.4: View Sequence Diagram

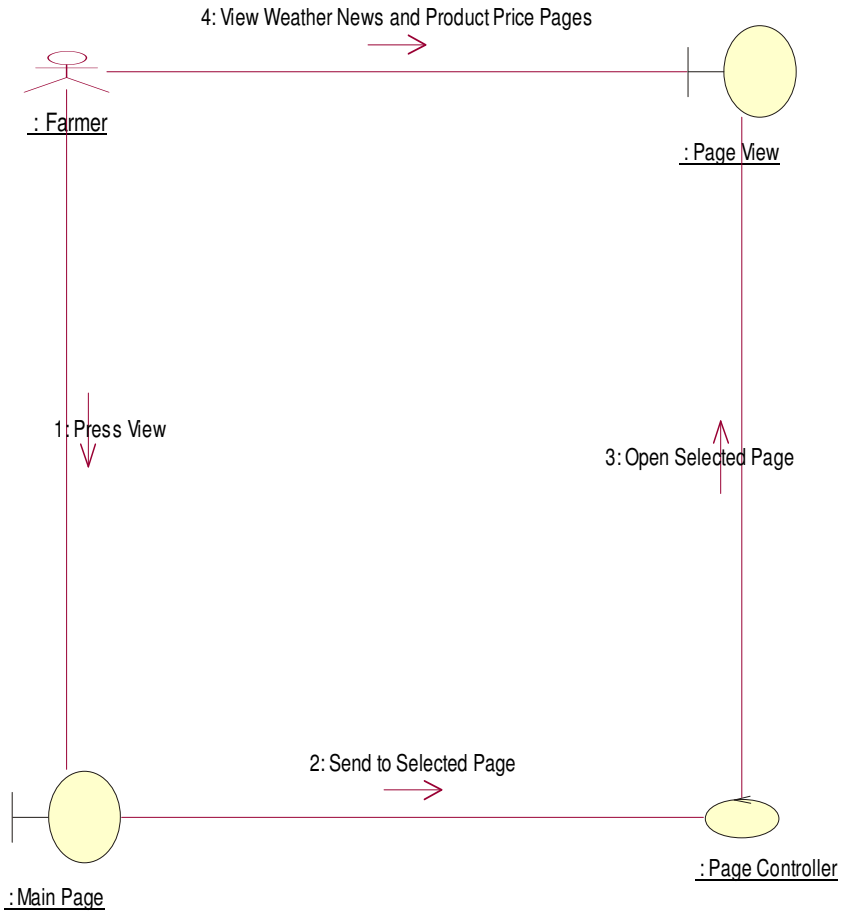


Figure 4.5: View Collaboration Diagram

4.6.3 Sequence Diagram for Select Day Use Case

This sequence diagram is initialised by farmers to view the weather status by selecting a certain day from the WAP weather information system day page.

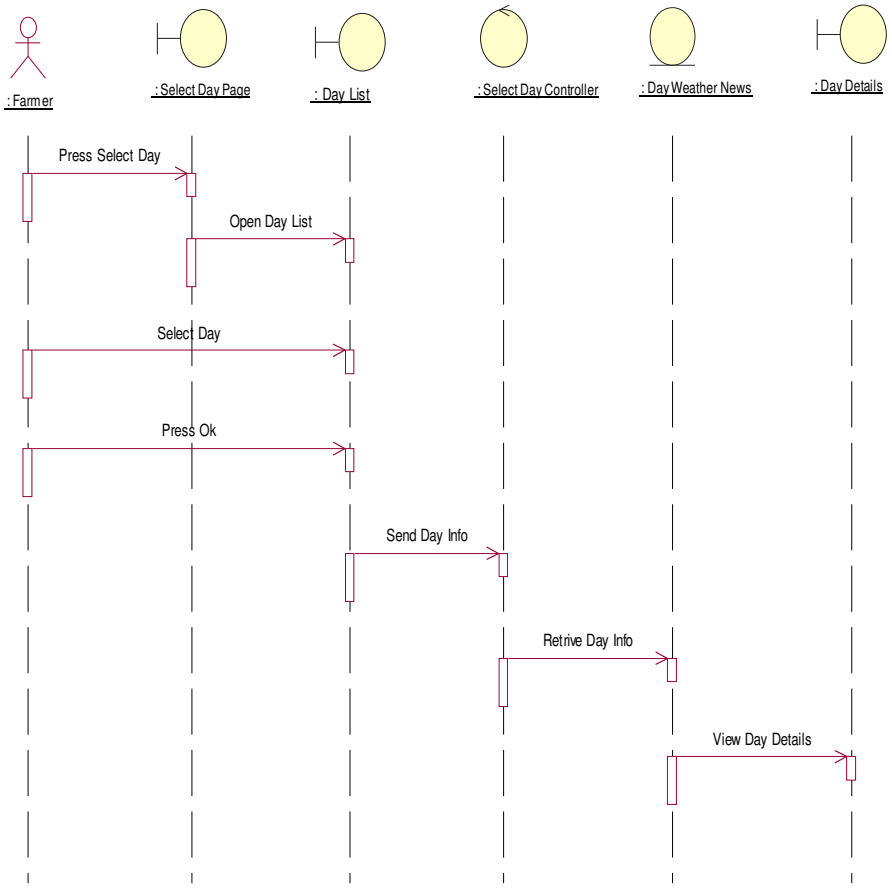


Figure 4.6: Select Day Sequence Diagram

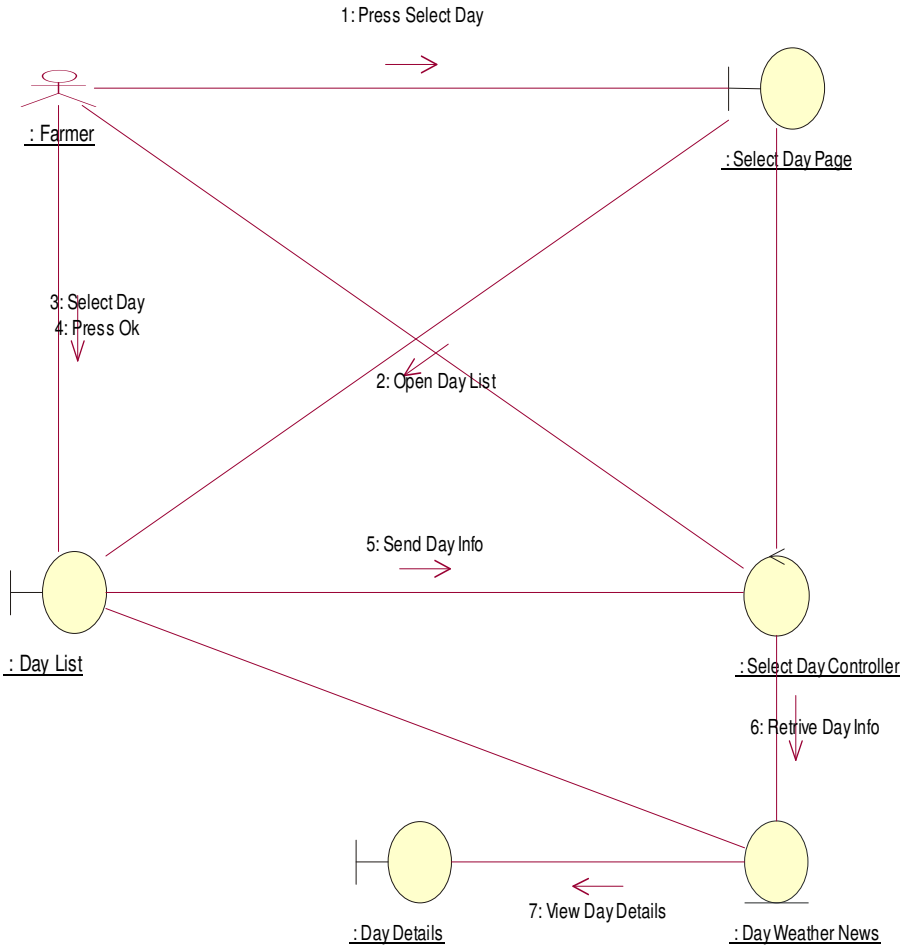


Figure 4.7: Select Day Collaboration Diagram

4.7 Use Test Case for the Use Manual

This use test case is used to present the user manual operations, such as test data input, expected result, actual result, defect, severity, and allocated to. The errors can be prioritised into high, medium or low:

.

- Low priority (L): aesthetics, message wording, menu options, wrong alarms, help problems, etc.

- Medium priority (M): When an error occurs leading to another error resulting in a variation in the functionality.

- High priority (H): When the application completely stops, the system gets hanged, etc.

1) Login Page

Figure 4.8: WAP Weather Information System Login Page

Table 4.5: Use Test Case for Login Page (Home)

No	Test Data Input	Expected Results	Observed / Actual Results	Defect (Y / N)	Severity (H-High, M-Medium, L-Low)	Allocated to
1.Login	User name Password	Access User Page	(Wrong user name and Password) or (Wrong Entries)	N	M	Farmers

2) Menu Page

Figure 4.9: WAP Weather Information System Menu Page

Table 4.6: Use Test Case for Menu Page

No	Test Data Input	Expected Results	Observed / Actual Results	Defect (Y / N)	Severity (H-High, M-Medium, L-Low)	Allocated to
2. Menu Page	Non	View Main Page	Not applicable	N	M	Farmer

3) Main Page

Figure 4.10: WAP Weather Information System Main Page

Table 4.7: Use Test Case for Main Page

No	Test Data Input	Expected Results	Observed / Actual Results	Defect (Y / N)	Severity (H-High, M-Medium, L-Low)	Allocated to
3. Main Page	Select Choices	View selected page	Not applicable	N	M	Farmer

4) Weather News Page

Figure 4.11: WAP Weather Information System Page

Table 4.8: Use Test Case for Weather News Page

No	Test Data Input	Expected Results	Observed / Actual Results	Defect (Y / N)	Severity (H-High, M-Medium, L-Low)	Allocated to
4. Weather News Page	Press Continue	View weather status	Not applicable	N	M	Farmer

5) Product Price Page

Figure 4.12: WAP Weather Information System Product Price Page

Table 4.9: Use Test Case for Product Price Page

No	Test Data Input	Expected Results	Observed / Actual Results	Defect (Y / N)	Severity (H-High, M-Medium, L-Low)	Allocated to
5. Product Price Page	Non	View Product Price	Not applicable	N	M	Farmer

6) Local News Page

Figure 4.13: WAP Weather Information System Local News Page

Table 4.10: Use Test Case for Local News Page

No	Test Data Input	Expected Results	Observed / Actual Results	Defect (Y / N)	Severity (H-High, M-Medium, L- Low)	Allocated to
6. Local News Page	Select news page	View Local News	Not applicable	N	M	Farmer

7) Select Day Page

Figure 4.14: WAP Weather Information System Select Day Page

Table 4.11: Use Test Case for Select Day Page

No	Test Data Input	Expected Results	Observed / Actual Results	Defect (Y / N)	Severity (H-High, M-Medium, L- Low)	Allocated to
7. Select Day Page	Select certain day	View weather news	Non	N	M	Farmer

4.8 Usability Testing and Evaluation

The application was evaluated by performing a monitoring of user's performance through a carefully constructed interview and questionnaire.

4.8.1 Conducting Test by Farmers

The execution of this project was motivated by the intention of providing more flexible and enhanced method of gathering information among the local community. With the purpose of giving alternatives to the farmers who require information on weather changes, the proposed application of the WAP Weather Information System for Farmers was developed with the capability of providing information on several selected features to satisfy with the farmer's requirements.

The requirements of the WAP Weather Information System for Farmers were gathered through interviews with randomly selected farmers and feedback from them about the WAP Weather Information System for Farmers. The interview questions probed about the current weather checking system and the current weather check problem that the farmers would face during their normal daily activities, and the interview also provided this study with the appropriate understanding of the impact of these problems faced by those farmers.

This chapter explained the application design of the WAP Weather Information System for Farmers that was presented by the UML diagrams however, these diagrams indicated the basic view of the proposed system. Furthermore, the

Unified Modelling Language (UML) was used to draw the necessary diagrams, such as use case diagram, sequence diagram, and collaboration diagram.

As a result, the WAP Weather Information System for Farmers was developed using the WML and ASP mobile programming to build the proposed application, and Microsoft Access was used to build the database tables in order to classify the data of the application. The proposed system can provide an alternative solution as a WAP Weather Information System for Farmers, with faster, simpler, and easier to use, and more convenient method of obtaining their information of about the weather.

4.8.2 Application Testing

This study had taken one week to perform the application testing. The testing environment was for Kedah farmers. The total number of respondents was 30. Around 50 questionnaire sets had been distributed in different places in Kedah, but 30 questionnaires were returned, which was used later to evaluate the proposed system.

QUESTIONNAIRE SENT	**50 Sets**
QUESTIONNAIRE RECEIVED	**30 Sets**
PERCENTAGE	**60% Return Back**

Table 4.12: Set of Questionnaire Gathered

Descriptive analysis applies to a record of observed data on a variable phenomenon. The record may be time dependent (e.g. rainfall measured in one spot) or space dependent (e.g. crop yields in an area). Table 4.13 presents the agreement to the questions of the returned questionnaire; all of the maximum, minimum, and the mean are presented for each question.

Table 4.13: Result of the System Usability

	N	Minimum	Maximum	Mean
Q1	30	1	5	3.10
Q2	30	1	5	3.71
Q3	30	2	5	3.71
Q4	30	1	5	3.76
Q5	30	2	5	3.76
Q6	30	2	5	3.62
Q7	30	1	5	4.52
Q8	30	2	5	3.76
Q9	30	2	5	3.62
Q10	30	2	5	3.86

4.8.3 Result Discussion

The agreement diagram showed in Figure 4.15 presents the findings of how easy to understand the web application. However, this result gave a strong relation for web understanding, which was a mean of 3.10.

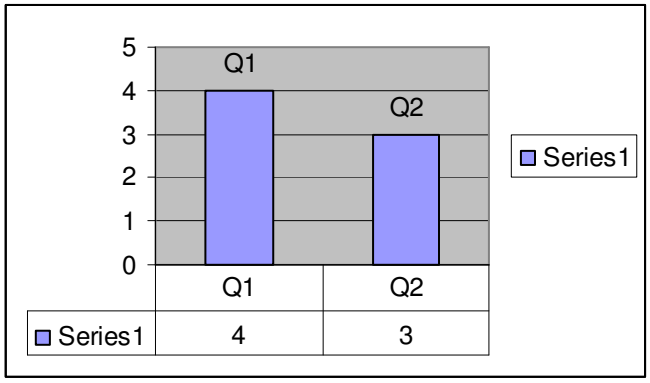
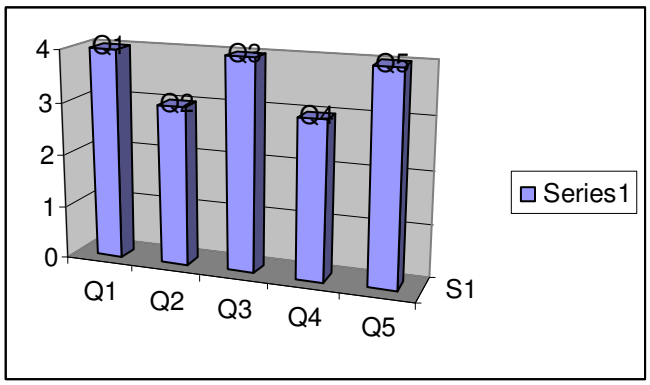


Figure 4.15: Information Gathering Diagram



4.16: Benefit of user Satisfaction

4.9 Summary

This chapter presented the analysis conducted; requirements for the WAP Weather Information System for Farmers have been able to be determined, which was shown as functional requirements and non-functional requirements. Among others, the project has managed to come out with several possible functions to be implemented in the WAP Weather Information System, which will enable farmers to:

- login by their username and password,
- view the weather information and status, and
- select the certain day to determine the weather status.

The result of the analysis was then referred to be the guide for designing the WAP Weather Information System for Farmers. In the design process, there were two steps involved: Logical Design and Physical Design. The project also adopted the object-oriented analysis, which applied the use case diagram for the purpose of designing the user interface.

Usability Testing and Evaluation was performed as an important part in the development process and can uncover usability deficits early during the design. In further work, more usability tests for the re-design application with more farmers should be conducted. Interviews with these test persons and evaluation to reach more people will help to shape the application to better meet the user's opinions, requirements, and expectations. The overall results were encouraging but improvement is definitely needed.

The Weather Information System for Farmers is capable of helping the public in general, more specifically farmers from rural areas by providing an easier way to access their the latest news by providing them with the necessary information that they require, such as the weather news, product price, and local news. The application was developed using WML, and ASP mobile programming was used to code the Weather Information System for Farmers. The study showed how the users can access their weather news using the mobile device or the select day option, and the results showed how the users were satisfied with this system. A Microsoft Access database was used to make the database that stored the necessary weather news information for the farmers. The application has been evaluated and the objectives for this research project have been achieved.

6

CONCLUSION

This chapter concludes the study by summarising and reviewing the findings that were found from the study, and presenting problems and limitations, as well as the direction for future research work.

6.1 Conclusion of the Study

As was explained through chapter one, the objectives of this study were to develop the application and perform a usability testing, as well as producing a requirements model for WAP Weather Information System for Farmers using UML.

The prototype will help the farmers in rural areas to do their queries for the different weather news easily anywhere at any time using their mobile phones, and that will save them from going to the TC office and from the limitations of using the website at these TC offices.

6.2 Problems and Limitations

Although this system provides the farmers with an easier manner for viewing the news, there are some significant disadvantages to the Weather Information System for Farmers, which include the following points:

1. The developing of WAP pages is more complex than developing pages for standard web browser because of the limitation related to the size of mobile screen space and internal memory in mobile devices. In the development phase, the developer needs to be concerned about the size of the screen.
2. The WAP application was tested using a local host server, namely IIS, but with the limited financial resources, no actual server was utilised in testing the proposed application.

6.3 Recommendation for Future Work

The Weather Information System for Farmers was to enable the farmer to get the appropriate and necessary information about the weather news update, such as weather news, product price, and local news. A lot of work is still needed to be done on this application in the future, by adding new features and capabilities such as browsing the weather news that support multimedia features, and sending messages from the administrator to the farmer in case there are some changes that may occur and they need to be informed about these changes.

REFERENCES

Abowd, Gregory D.; Atkeson Christopher G.; Hong, Jason; Long, Sue; Kooper, Rob; Pinkerton, Mike. (1997). Cyberguide a mobile context-aware tour guide. Baltzer/ACM Wireless Networks.

Atanas Rountev, O. V., Miriam Reddoch (2006). Static control-flow analysis for reverse Engineering of UML sequence diagrams. 31(1): 96 – 102.

Atle Refsdal, K. S. (2008). Extending UML Sequence Diagrams to Model Trust-Dependent Behaviour with the Aim to Support Risk Analysis. 197(2): 1529.

Bahrami, A. (1999). Object Oriented System Development, McGraw-Hill, United States of America.

Bennett, S., McRobb, S., & Farmer, R. (2002). Object-oriented System Analysis and Design 2nd Edition. UK, McGraw Hill.

Bhattacharyya, D. (1997). Mediating India: An Analysis of a Guidebook. Annals of Tourism Research 24(2):371-389.

Bhavnani, A., Chiu, R., Janakiram, S., Silarszky, P., & Bhatia, D. (2008). The Role of Mobile Phones in Sustainable Rural Poverty Reduction. ICT policy division global information and communications department (GICT).

Cheverst, Keith; Davies, Nigel; Mitchell, Keith; Friday, Adrian (2000); Experiences of developing and deploying a context-aware tourist guide: The Guide project International Conference on Mobile Computing and Networking, Boston, ACM.

Davis F. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. MIS Quarterly, 13(3), P (319-340).

Dennis, A., Wixom, B.H., & Tegarden, D. (2005). System analysis and design with UML version 2.0: an object-oriented approach with UML, 2nd edition. Hoboken, NJ: John Wiley and Sons, Inc.

Dunham, M., et al. (1995). Mobile Computing and Databases: Anything New?

Elalfy E. (2005). A General Look at Building Applications for Mobile Devices. Distributed Systems Online, IEEE, 6(9), 1-3. Retrieved Dec 30, 2008 from: http://csdl2.computer.org/comp/mags/ds/2005/09/o9005.pdf.

Eriksson, H., & Penker, M. (1998). UML Toolkit. USA, John Wiley & Sons, Inc.

Erlandson & Ocklind, (1998). WAP- The wireless application protocol. Pages 165-174 in Mobile Networking with WAP. ISBN: 3-528-03149-2.

Goto, K., Matsubara, H., Myojo, S. (1999). Autonomous Decentralised Systems, Integration of Heterogeneous Systems Proceedings, the Fourth International Symposium, pp. 12-17.

Hoffer, J. A., George, J. F & Valacich, J. S. (1999). Modern Systems Analysis and Design (2nd Edition). United Kingdom: Addison Wesley Longman.

Hoffer, J. A., George, J. F & Valacich, J. S. (2002). Modern Systems Analysis and Design (3rd Edition) Upper Saddle River, New Jersey: Prentice Hall.

Hulberts, S.J. C. (1989). How Important Is Mobile Communication for a Truck Company? Proceedings of the Vehicle Navigation and Information Systems Conference, 11-13 Sep 1989, pp. 361-364.

Imielinski, T. and Badrinath, B. (1994). Mobile Wireless Computing - Challenge in Data Management, Communications of the ACM, 37(10) (1994) 18–28.

Imulienski, T., & Badrinath, B. (2001). Mobile Wireless Computing: Solutions and Challenges in Data Management. Retrieved from: http://citeseer.ist.psu.edu.html.

Imulienski, T., & Badrinath, B. R. (2001). Mobile Wireless Computing: Solutions and Challenges in Data Management. Retrieved from: http://citeseer.ist.psu.edu/imielinski93mobile.html.

International Federation of Agricultural Producers (IFAP) (2008). About the International Federation of Agricultural Producers. Retrieved on 3 Jan 2008.

Jacobson, I., Christenson, M., Johnsson, P. & Overgaars, G. (2004). Object-oriented Software Engineering: A Use Case Driven Approach (revised). Harlow, England: Addison-Wesley.

Jagoe, A. (2003). Mobile Location Services: The Definitive Guide. Upper Saddle River, New Jersey: Pearson Education Inc.

Kendall, P. A. (1996). Introduction to Systems Analysis and Design: A Structured Approach, Irwin, Times Mirror Higher Education Group, USA.

Kothari C. (1985). Research Methodology, Methods and Technique. Delhi: Wiley Eastern Limited.

Kramer, R., & Modsching, M. (2005). Development and evaluation of a context-driven, mobile tourist guide. International Journal of Pervasive Computing and Communication (JPCC).

Kray, C., Baus, J. (2003). A survey of mobile guides. Workshop HCI in mobile guides Mobile HCI, Italy.

Lieslehto, K. (2000). WAP Application for PID Controller Tuning, Proceedings of the 2000 IEEE International, Symposium on Computer-Aided Control System Design, Anchorage, Alaska, USA, pp. 168-172.

Nielsen, J. & Landauer, T. (2001). A Mathematical Model of The Finding of Usability problems. In ACM Interchi'93. Netherlands: Amsterdam.

Parikh, T., & Lazowska, E. (2006). Designing Architecture for Delivering Mobile Information Services to the Rural Developing World. Retrieved: Jan 5, 2009. From: http://www.cs.washington.edu/papers/www2006-parikh.pdf.

Petra Blixt (2005). Mobile Telephony in Rural India, Stockholm, Sweden 2005.

Polylab (1998). WAP Architecture. Retrieved Jan, 3, 2009, from (http://polylab.sfu.ca/spacesystems/teach/wireless/wap/. PDF).

Raffaele B., Marco C., & Enrico G., (2005). Mesh Networks: Commodity Multihop Ad Hoc Networks. IEEE Communications Magazine, 43(3):123–131, March 2005.

Schmuller, J. (2002). SAMS teach your self UML in Hours. SAMS Publishing, Indiana.

SIGMOD Record, Special Section on Data Management Issues in Mobile Computing, 24(4): December (1995) 5–9.

Silva, P.P.D. & Paton, N.W. (2003). UML: The Unified Modelling Language for Interactive Applications. Retrieved from:

http://scholar.google.com/scholar?q=UMLi:%20The%20Unified%20Modeling%20Language%20for%20Interactive%20Applications&hl=en&lr=&oi=scholart.

Sommerville, I., (2001). Software Engineering (6th Ed.). Harlow, England: Addison Wesley. Sparxsystems's UML Tutorial Page (n.d.). Retrieved from: http://www.sparxsystems.com.au/UML_Tutorial.htm.

Tétard, F. & Patokorpi, E. (2004). Design of a Mobile Guide for Educational Purposes, Conference '04, ACM, pp. 1-7.

U.S House of Representative (1999). Systems Development Life Cycle, pp. 1-12.

WAP (2005), retrieved Jan, 2, 2009 from (http://searchmobilecomputing.techtarget.com/sDefinition/0,sid40_gci213337,00.html).

WAP Forum (2000). Wireless Application Protocol White Paper. Retrieved: Jan 2, 2009. From: http://www.wapforum.org/what/WAP_white_pages.pdf.

WAP Forum (2001). WAP Architecture. Wireless Application Protocol Architecture Specification.WAP-210-WAPArch-20010712. Retrieved: Jan 2, 2009. From: http://www.openmobilealliance.org/tech/affiliates/wap/wap-210-waparch-20010712a.pdf.

WAP Forum (2002). WAP 2.0 Technical White Paper. Retrieved April16, 2007 from http://www.wapforum.org/what/WAPWhite_Paper1.pdf.

WAP, (2008), Wireless Application Protocol, retrieved on 12 Sep 2008, (http://en.wikipedia.org/wiki/Wireless_Application_Protocol).

Whitten J., Bentley L. & Dittman, K. (2001). System Analysis and Design Methods (5th Ed.) McGraw Hill: Boston.

Wireless Application Protocol Forum (1998). Wireless Application Protocol Architecture Specification, WAP Architecture Version 30. From (http://www.silicon press.com/briefs/brief.wml/brief.pdf).

Wireless Application Protocol Forum (1999). Wireless Application Protocol, Wireless Markup Language Specification Version 1.2. Retrieved April 16, 2007 from: http://www.wapforum.org/what/technical/SPEC-WML 19991104.pdf.

Yakasai, R. (2008). Rural Internet Propagation Enhancement (RIPE). A Position Paper to Workshop on Role of Mobile Technologies in Fostering Social Development June 2-3-2008, Sao Paulo, Brazil. Retrieved: Jan 3, 2009. From:http://www.w3.org/2008/02/MS4D_WS/papers/RIPEsystem_1_.pdf.

Yakasai, R. (2008). Rural Internet Propagation Enhancement (RIPE). A Position Paper to Workshop on Role of Mobile Technologies in Fostering Social Development June 2-3. Soohoo, K. (1997). Multi-Function Internet Appliances. 14 – 18.

Yiwei C., Martin K., Georgios T. & Sadeq M., (2006), Mobile Community Information Systems on Wireless Mesh Networks, An Opportunity for Developing Countries and Rural Areas, 2 Aug 2006, by worldwide-cellular users.

Appendix A

Universiti Utara Malaysia
College of Arts and Science

SURVEY OF WEATHER INFORMATION SYSTEM FOR FARMERS BASED ON WAP TECHNOLOGY

SECTION A: Demographic Background

Please kindly tick (√) your answers to the given statements.

GENDER :

☐ Male.

☐ Female.

AGE :

☐ 18-25 Years old.

☐ 26-34 Years old.

☐ 35-44 Years old.

☐ 44-54 Years old.

☐ Above 55 Years old.

MARITAL STATUS :

☐ Married.

☐ Single.

EDUCATION BACKGROUND:

☐ Have Education Background.

☐ Don't Have Education Background.

SECTION B: Visual aspects of the Application usability

Please check the appropriate column. The numbers 1 to 5 represent the following:

1= Strongly Disagree. 2= Disagree. 3= Not Sure.

4= Agree. 5= Strongly Agree.

	Question	1	2	3	4	5
1	Is the information provided in the WAP form easy to understand?	☐	☐	☐	☐	☐
2	Is there information on the WAP Weather News system page telling you what is included?	☐	☐	☐	☐	☐
3	Does the WAP page lead you to some other good information (links)?	☐	☐	☐	☐	☐
4	Would it have been easier to get the information somewhere else?	☐	☐	☐	☐	☐
5	Are you interesting in browsing WAP Weather News system?	☐	☐	☐	☐	☐
6	Do we provide the kind of content that you would expect to find on our WAP Weather News system?	☐	☐	☐	☐	☐
7	Is the WAP Weather News system beneficial for the people in the rural areas?	☐	☐	☐	☐	☐
8	Do you think that the balance of graphics and text on the WAP application is suitable, or would you like more or fewer graphics?	☐	☐	☐	☐	☐
9	What do you think of the text size, is it suitable?	☐	☐	☐	☐	☐
10	Do you find the current WAP Weather News system appealing?	☐	☐	☐	☐	☐

SECTION C: Information Gathering

Please kindly tick (√) your answers to the given statements.

- What kind of information are you looking for?

☐ Local News.

☐ International News.

☐ Social Events.

☐ Announcements.

- From where do you get the news?

☐ Newspapers.

☐ Announcements.

☐ Mouth to mouth.

☐ Television.

SECTION D: Benefits and User Satisfaction:

Based on using the **WAP Weather Information System** as a new system alternative for current system, please indicate your choice of YES or NO according to the given statements.

1- Does the **WAP Weather Information System** enable you to view the various news items?

☐ Yes. ☐ No.

2- Do you consider the **WAP Weather Information System** as effective in providing you with the live news?

☐ Yes. ☐ No.

3- Do you consider the **WAP Weather Information System** will satisfy the people in this area?

☐ Yes. ☐ No.

4- Does the **WAP Weather Information System** provide you about the new news?

☐ Yes. ☐ No.

5- Are you satisfied with the **WAP Weather Information System**?

☐ Yes. ☐ No.

This is the end of questionnaire.

Thank you very much for spending your time to complete this questionnaire.

In case you need to contact me with regard to this survey, please contact me by e-mail:
allatif4@yahoo.com

(Name)

Available at:
http://www.questionpro.com/academic/online-survey-research-User-Acceptance-Survey.html