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WIRELESS ORDERING & RESERVATION SYSTEM (WORS)

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Abstract

Wireless Ordering & Reservation System or in short called **WORS** is a restaurant system which is based on the wireless environment. Most of the restaurants today are still using the old-fashion way of taking orders and reservation on a piece of paper. This kind of practice is very troublesome, inefficient and not systematic at all.

By implementing WORS, customers will be able to make their reservation through their mobile phone whereas waiters and waitresses will be using wireless pocket PC for ordering process. In fact, this project is important in bringing the restaurant system to the new age to accomplish the growth of the "Wireless Technology". Besides, WORS will be able to keep track of all transaction into the database and generating the sales report in a period of time.

In order to provide more efficient and better quality services, this project will be developing through several stages. Information was gathered on the development models and tools. Apart from that, research was done on the similar system to study the strengths and weaknesses of the current system.

The Waterfall Model with Prototyping approach was chosen for the development of this project because the strengths of both the waterfall model and prototyping can be combined in a single project and reduces the risks involved.

Software and technology selection are Microsoft Windows 2000 server, Microsoft Internet Information Service 5.0, Microsoft SQL server 2000, Wireless Markup Language (WML), WML script, Active Server Pages 3.0, Microsoft Visual Basic 6.0 and Microsoft eMbedded Visual Basic 3.0. And the system requirement of this WORS is the client-server technology with three-tier technology.

During the early stage, many problems were inevitably encountered due to the high degree of uncertainty in some area of user requirements, system requirements, complexity and unfamiliarity of setting up and configuration the servers.

Finally, this project outcome will reflect the characteristics of information such as accuracy, reliability, timely and integrity.

Table of Content

List of Figures

List of Tables

CHAPTER 1

INTRODUCTION

Chapter 1: Introduction

1.1 Project Definition

In the past, computer technology was still new for us and most of the hotel restaurant conventional commercial activities had been conducted in manually. For instance, waiter and waitress were using pen and paper in taking order and cashier was manually calculating the entire item which has been ordered. When the computer technology was introduced, the traditional problem still has not been fully solved.

There have two major problems that are always faced by the restaurant. First, customers were lead to wait for a long time to be served when the restaurant is busy. Redundant time is spent by waiter and waitress for walking around the restaurant to interact between customer and kitchen or bar. The second problem is high probability wrong order taking by waiter and waitress. This is caused by error in interpretation of handwritten orders by waiter or waitress. With this two major problem, business goal or budgeting will be affected because of the customer dissatisfy of the services provided.

Besides that, hotel restaurant online booking system has a limitation when wireless technology has not been founded. The limitation shows that customer cannot directly book a table in restaurant at any time and place. The customers have to connect to the internet web site via personal computer.

In order to solve the problems and the constraint above, I proposed a direct system entitled "***Wireless Ordering & Reservation System (WORS)***". The problems can be solved where the waiter and waitress will use handheld wireless device to talking order. By using handheld device in the ***WORS system***, waiter and waitress can easily taking order which is requested by customer and posting the order by POS system when pressing a send button rather than walking to the counter sites and place the order. This system is like a message sending between a sender and a receiver. For instance, when the order have been taken, the waiter and waitress just press a button on the handheld computer to send the

order to the kitchen and the kitchen will receive the order and prepare the food for the customer. When the food is ready, the cook can using the computer system in kitchen, touch screen computer system, to notice the waiter and waitress which table food is ready to serve. Communication by using wireless transaction will reduce the redundant time. The aim of this proposed system is to replace the pad of paper and pencil that waiters carry around today in high-volume restaurant and reduce the time interaction time between customer and kitchen or bar.

Besides that, the limitation of the web can be achieved by using ***WAP*** (Wireless Application Protocol) technology. This protocol is aimed to unify Internet and mobile telecommunication as well as to standardize the technology of the development of applications and services for work within the wireless network. Customers can use their mobile phone to access the reservation purpose in WORS system.

1.2 Objectives of the System

In order to achieve this aim, the **objectives of the system** are set out as below:

- To provide **fast and efficient ordering process** by using the handheld device. Such device provides advantage for the waiter or waitress to take down the order from the customer in a shorter time. This is by which the waiter or waitress taking down the order by just touched on the handheld devices. Once the orders are taken from the Handheld Computer, it will rapidly transfer to kitchen, bar and cashier to enable faster turn around of order.

- Enables to provide an **accuracy of orders.** When the server places an order, it is transmitted to the kitchen or bar, and the orders will preview in the screen of touch panel computer for bartenders and food prep personnel to read. No harder to read handwriting, no more forgotten modifiers (give away items). No more angry chefs who cannot read an order. If a mistake is made, the database copy is available for the manager to find out when the order was sent to the kitchen, what time, and by whom

- The system is very **ease to use and user friendly**. This is due to the simplicity of the point of sales system with icons and touch screen technology can assist the user to enter the order more efficiency. Besides, the user interface enables the waiter or waitress to rapidly gain skills in using the system.

- Enable to **generate report** for top management. This is by which enable the manager to view the sales report for their daily sales transaction. Besides, such report can be formed or view by daily, weekly, monthly and yearly in order to manage the accounting purpose in more effective.

- Enable to **preset food menu and price** in the system. This to enable the top management to edit new food menu into the system. Besides, it also able to update the price for the particular meal.

- This system enables to do **reservation purposes**. This system will provide a 24*7 service period for customer to book a table. Thus, this system can record down the customer information and type of reservation is made.

- This system will **reduce time redundancy** in serving customer. The system enables to increase sales potential. Efficient management in maximizes the restaurant's productivity; by reducing the guests' wait time, as well as the table turn time. The end result is an increase in number of guests served, and therefore an increase in sales and profitability

1.3 Project Scope

The scope of WORS:

- WORS will fully integrate in wireless environment except for internet connection to ISP.
- There are five levels of WORS user that are manager, pos administrator, web administrator, restaurant workers (server, kitchen, bar and cashier) and registered customers (for reservation purpose).
- The customer will use their WAP enable mobile phone to make a table reservation in the WORS.
- WROS will provide a 24*7 service time for reservation purpose.
- WORS will provide a registration features for new customer to register and have a right to make a reservation.
- Customer can check out the table information and choose a comfortable table's location during the reservation.
- WORS will provide a graphical user interface display in each functional screen.
- Wireless handheld computer will enable server to take an order from guests and no paper work involved.
- POS administrator has a right to add a new item, modify the existing item and delete the item in the menu database.
- WORS will keep track of all transactions in the database server.
- WORS will generate a sales report in a period of time for manager.
- WORS will notify to server when the foods or drinks were prepared.
- WORS will allow the guest paying by credit card or cash and all transaction under Ringgit Malaysia.
- WORS will force user to login and to identify the authentic user.
- WORS will provide a feature to trace back the record to check out who was made a wrong order and when the order was made.
- WORS will provide a feature for server to preview the items which have been ordered in handheld computer.

1.4 Project Limitation

The limitations of this project are shown as below:

- This project will not perform the real handheld Device and Touch Panel Screen Computer. The Handheld device will replace with the emulator and the touch panel screen will replace by mouse device.
- This project will not perform the connection with wireless. The connection to each device will be performed in traditional intranet connection.
- SQL server, web server and Windows 2000 server will perform into a same pc.
- Inventory control system will not functioning in this system.
- This project is not a fully online system and the online system specific for WAP application. As a result, internet web portal will not be developing in this project.
- This project does not incorporate with any merchant account or relationship with the banking system. As a result, the online credit card system will be for demonstration purposes and there is no actual transaction is taking place. The credit card information will only be stored in the database.
- This WORS will not support the real credit card payment system because of no actual credit card reader machine.
- This system is only a prototype version, and part of the module will be under simulation purpose.
- Language selection is not available and English language is used as the system default.

1.5 System Assumption

- This project will assume that each emulator will perform the task same with the real handheld device.
- All connection will perform as well as wireless connection.
- Handheld emulator in a computer will be assumed as the whole handheld device in the restaurant.
- This system has an access line directly linked to the internet.

1.6 Software Requirement

1.6.1 Hardware requirement

Server site

- 400MHz or faster Pentium-compatible CPU
- 10.2 GB hard disk space and above
- 128 Mb physical memory
- Wireless Network interface card
- Printer
- Modem 56kbs
- Uninterruptible Power System

Client site

- IPAQ H360
- D-Link DCF-650W (wireless Compact flash Types II Card)
- WAP phone
- Touch panel screen monitor
- 400MHz or faster Pentium-compatible CPU
- 10.2 GB hard disk space and above
- 128 Mb physical memory
- Uninterruptible Power system

1.6.2 Software requirement

Platform	Windows 2000 server with SP2
Database	Microsoft SQL server 2000
Web server	Internet Information Service 5.0 (IIS)
Markup Language	Wireless Markup Language (WML)
Scripting Language	WML script, VB script, Java script
Server Programming Environment	Active Server Pages 3.0
Programming Language	Microsoft Visual Basic 6.0
WAP toolkit	Nokia WAP Toolkits 2.0
Handheld Development toolkit	Microsoft eMbedded Visual Basic version 3.0
Emulator(Pocket PC)	Microsoft CE Platform SDK for Pocket PC (Desktop Pocket PC Emulation)

1.7 Project Schedule

ID	Task Name	Duration	Start	Finish
1	Literature Studies	40 days	Mon 6/4/01	Thu 7/19/01
2	Requirement Definition	36 days	Mon 6/18/01	Sat 7/28/01
3	System Analysis	30 days	Mon 7/9/01	Sat 8/11/01
4	System Design	24 days	Mon 7/23/01	Sat 8/18/01
5	System Development	105 days	Mon 8/6/01	Wed 12/5/01
6	Testing	60 days	Sat 11/3/01	Fri 1/11/02
7	Documentation	70 days	Wed 11/21/01	Sat 2/9/02

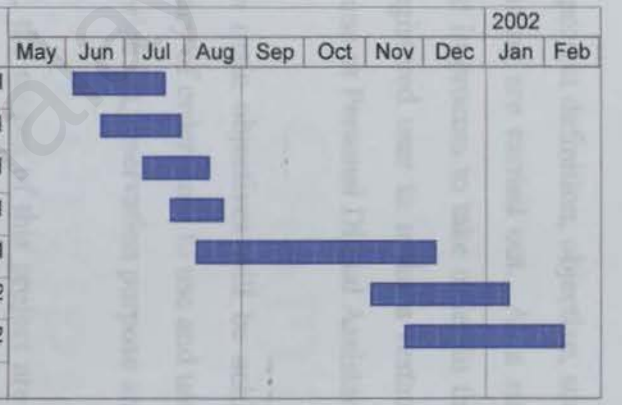

Figure 1.1 Project Schedule

1.8 Summary of Chapter 1

In this chapter, project definition, objective, scope, limitations, assumption, system requirement and scheduling are carried out. As a summary, WORS will enable servers using wireless handheld in process to take order in the restaurant environment. Besides, WORS also will let registered user to make a restaurant table reservation by using the WAP enable mobile phone or Personal Digital Assistance (PDA).

There are seven main objectives will be achieve, which are fast and efficiency ordering process, accuracy of order, ease to use and user friendly, enable to generate report, pre set food menu and price list, reservation purpose and reduce time redundancy.

Apart from that, the scopes of this project are also described. The scopes of this project can be defined as a boundary of a project. And the boundary of this project will be restricted by the project limitations. The limitations of this project can be described as technical limitation, tools limitations, facility limitation and time limitation. Therefore, some assumptions have been made to cover up the limitation.

The system requirement also state in this chapter. The requirement of this system can be divided into two sections that are hardware and software requirements. The hardware is computer equipment which is needed in this project. Besides, the software is an application tools that is needed to develop the system.

Finally, the project schedule which is scheduled in a Gantt chart represents each task or activities. The time periods allocated to literature studies, system analysis, system design, system development, testing and documentation is from 4th June 2001 to 10th February 2002 is about eight months time.

CHAPTER 2

LITERATURE REVIEW

Chapter 2: Literature Review

2.1 Introduction

A literature review of a project is important as it places the project in the context of others, which might have a similar characteristic. It helps the developer to know some of the existing feature offered by a similar system.

There is no use of reinventing the wheel that has already been invented. The developer can rather focus on learning the existing system and modify or enhance it into a more advance and powerful feature for the project.

Another important purpose of a literature review is to sufficiently equip the developer with some knowledge of the strengths and limitation of several development tools. This can help the developer to choose the right tool in system development.

2.1. WAP Technology

2.2.1. Introduction to WAP

Wireless Application Protocol (WAP) is a set of protocols that allow for the development of Internet and Web-based services for mobile phones and other mobile devices. The WAP standard was developed by the WAP Forum whose founding members include Ericsson, Motorola, Nokia and Phone.com and addresses the limitations of mobile networks (low bandwidth, high latency, and unpredictable availability and stability) and mobile devices (limited CPU, memory, and battery life, and a simple user interface). The WAP Forum has developed their standards in such a way that they leverage and compliment existing industry standards as much as possible. The WAP standard specifies two essential elements of wireless communication: an end-to-end application protocol and an application environment, the Wireless Application Environment (WAE), based on a browser.

The WAP defines a set of protocols in the transport, the session, and the application layers. It also specifies an application framework. Furthermore, it has been developed to meet challenges in building advanced differentiated services and implementations in a fast and flexible way. [7, 8]

2.2.2. WAP Architecture

Working with WAP architecture is very similar to working with traditional Web application architecture. A WAP Gateway act as an interface between the TCP/IP world and the mobile phone, translating information into a wireless protocol and passing into and from the phone. WAP utilizes plain Web HTTP 1.1 servers leveraging existing development methodologies like CGI, ASP, NSAPI, JAVA, Servlets, etc. Wireless Markup Language WAP doesn't use HTML for developing or designing web pages viewed by the handset. It instead uses a markup language of its own, called the WML.
The following figure 2.1 shows a typical deployment of a WAP based application.

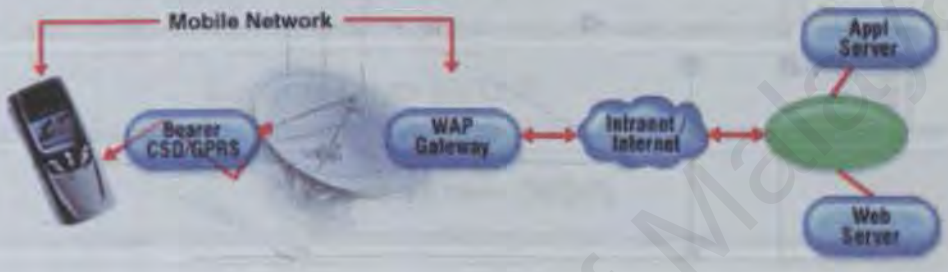

Figure 2.1 WAP Architecture [4]

In the Figure 2.1, the following happens:

- The WAP client (mobile phone) connects to the mobile network, typically a Circuit Switching Data (CSD) Bearer (a medium use to transmit information). The connection can be initiated by dialing a specific number(s), provided by the mobile operator. As part of the connection, the client submits the IP Address of the WAP Gateway and the WWW-URL of the Web Server. [4]
- The CSD Bearer establishes the connection with the WAP Gateway over the mobile network. [4]
- The WAP Gateway translates (decodes) the WAP requests into WWW requests, making an HTTP request to the Web Server as identified by the URL submitted by the client. The Web Server can be either on the Internet or an Intranet. [4]
- The Web application performs the required action and returns the result in WML format to the WAP client over the HTTP protocol. If the web application returns HTML response, then the WAP Gateway performs the translation of HTML->WML before sending it to the WAP client. [4]

2.2.3. WAP Layers

The WAP is a layered protocol stack that contains a session protocol, a transaction protocol, a security protocol, and a data gram protocol. This stack isolates the application from the bearer when used as a transport service.

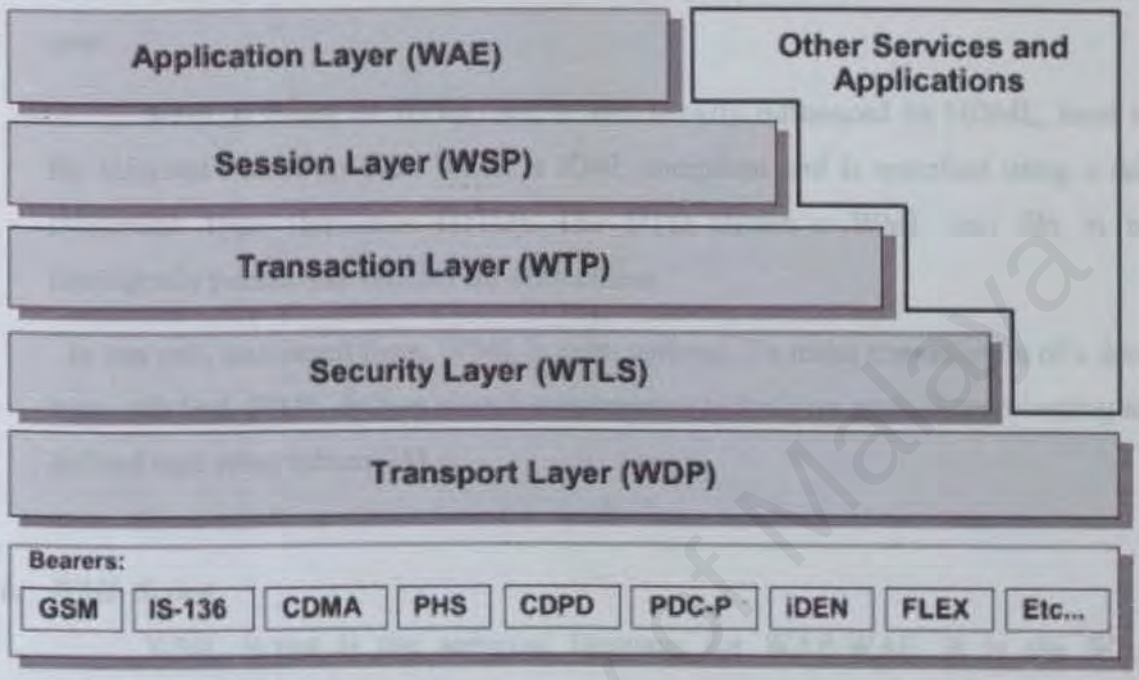

Figure 2.2 WAP Protocol Stacks [9]

2.2.3.1. Application Layer - WAE and WTA

Wireless Application Environment (WAE) and Wireless Telephony Application (WTA) are the top-most layers in the WAP architecture. They are the main interfaces to the client devices and specify a markup language, a scripting language, and a telephony interface. WAE and WTA impose a few, simple and basic requirements on the client device. For example, the client device must maintain a "history list" of recently visited decks, so that the user may navigate "backwards". [8]

WAE consists of WML and WML Script plus the WML Script virtual machine. WTA is a separate, standalone function.

a. Wireless Markup Language (WML)

WML is the markup language for WAP-WAE. It is the WAP equivalent of HTML. WML formalizes the concept of cards and decks discussed in 2.2.1. Much like HTML, WML uses "tags", such as "" and "", to identify the purpose and function of blocks of text so that the client device can properly display, or render, them to the user.

WML is based on HTML and is also heavily influenced by HDML, used in the Unwired Planet product. WML is XML compliant and is specified using a full Document Type Definition (DTD). The DTD allows a WML text file to be intelligently parsed and verified for correctness.

In this raw, text-based form, WML is quite verbose. To make transmission of a deck more efficient, WML defines simple compression techniques such as representing all defined tags using tokens. [8]

b. WML Script

WML Script is the scripting language for WAP-WAE. It is the WAP equivalent of JavaScript. WML Script is a high level language that allows a content provider to implement arbitrary functions that may be required by individual WML decks, for example, to verify form input prior to submitting it to a server.

As with WML, WML Script is quite verbose and a compression / compilation scheme is defined to make transmission much more efficient. Compiled WML Script consists of machine-independent byte codes, much like Java's compiled class files.

WML Script obviously requires an operating environment where the byte codes are executed in an interpreted mode. This "virtual machine" is similar to the Java Virtual Machine (JVM). WAE specifies a set of library and system functions that all client devices must implement and provide by default. This provides a basis upon which content providers may build their applications regardless of the exact client device. [8]

c. Wireless Telephony Application (WTA)

WTA, as mentioned in above, provides a set of functions that allow control over the client device assuming it is a telephone device. Calls may be placed or answered. This part of WAP is still in the early stages of the specification process, so further information will not be provided at this time. [6]

2.2.3.2. Session Layer - WSP and WTLS

Wireless Session Protocol (WSP) and Wireless Transport Layer Security (WTLS) is the session layer of the WAP architecture. They provide connection-based services to the application layer - WAE and WTA. Basically, a session is started, content is exchanged, and the session is later closed. Additionally, the session can be suspended and resumed.

a. Wireless Session Protocol (WSP)

The Wireless Session Protocol (WSP) provides ways to establish a session from client to server, agree on used protocol functionality, exchange content, and suspend and resume sessions. It provides both connection-mode session and non-confirmed, connectionless services. The core of the WSP is the HTTP v1.1 protocol and all the methods defined by the HTTP v1.1 are supported. When providing connection-mode, the WSP utilizes the Wireless Transaction Protocol layer. In the case of connectionless mode, the WSP takes advantage of the Wireless Data gram Protocol layer. [11]

b. Wireless Transport Layer Security (WTLS)

WTLS is the WAP equivalent of the HTTP SSL or TLS. Security is provided using encryption of all session data using a cryptographic technique that is negotiated when the connection is established. WTLS is not very well defined at the moment and is currently optional in WAP. [12]

2.2.3.3. Transport Layer - WTP and Bearer Service

Wireless Transport Protocol (WTP) and bearer services are the protocol layer in the WAP architecture. They provide reliable transmission of WSP data packets between the client and server over a wireless link. [5]

a. Wireless Transport Protocol (WTP)

WTP is the WAP equivalent of TCP or UDP. Although WTP should provide reliable communication to WSP, the current specification allows for reliable (TCP-like) or unreliable (UDP-like) communication. When the connection is unreliable, WSP (unfortunately) is responsible for retransmission to make the connection reliable.

WTP is responsible for packet segmentation and reassembly and for acknowledgement of packets and retransmission of lost, unacknowledged, or corrupted packets. WTP numbers packets so that an at-most-once policy is effected. This ensures that a retransmitted packet is not mistaken for a new packet, which would cause duplication.

The "bottom end" of WTP consists of adaptation elements that match WTP functionality to the underlying bearer service, such as SMS or CDPD. In a sense, these adaptation elements "take up the slack" between what WTP needs and what the bearer service provides.

Each client device will probably have only one adaptation element since each client device will probably have only one wireless link. It is possible, however, that a client device may have a single wireless link that it can use in different manners. For example, GSM may provide different types of data services and each would require a different adaptation element (not to mention a mechanism for the user to specify which one to use). [5]

b. Bearer Services

The bearer service is the wireless data link between the client and a server. Many different bearer services are possible: CDPD in the analog cellular system, SMS and GPRS in the GSM cellular system, and one-way (traditional) and two-way paging. Each one of these has its advantages and disadvantages in terms of maximum / typical throughput rates, round-trip delay times, and cost.

Each client device must obviously have at least one bearer service and some client devices may have several, for example, with GSM phones. [5]

2.2. Client-Server Architecture

The client/server model is an approach to software in which one application (the client) asks for and receives services from another application (the server). Client/server is a concept of computing as seen from the enc user's viewpoint- not that of the system or the application. In a client/server environment, data are manipulated at the user level. Client/server computing can be considered totally user-driven, and the client/server environment can be envisioned as a multivendor, multiproduct, multi-application implementation. Essentially, client/server computing is a software-based architecture that enables distributed computing resources on a network to share common resources among groups of users at intelligent workstations.[22]

Client/server computing is an environment that satisfies the business need by appropriately allocation the application processing between the client and thee server processors. The client requests services form the server; the server processes the request and returns the result to the client. The communications mechanism is a message passing interprocess communication (IPC) that enables (but does not require) distributed placement of the client and server processes. Client/server is a software model of computing, not a hardware definition. Though client/server architecture can be very complex, there are generally speaking, two kinds of client/server infrastructures to choose from. They are two and three-tiered. The choice between two-tier and three-tier architecture should be based on the scope and complexity of a project, the time available for completion, and the expected enhancement or obsolescence of the system.[22]

- ***Advantages of Client Server***

Client/server is an open system. It offers organizations the ability to distribute processing and data across networks using powerful graphical workstations, servers, and mainframes, the client/server model enables rightsizing, the selection and location of computing resources according to the needs of individuals and work groups. One of the prime benefits of a client/server system is lower cost. Another is increased productivity form the individual to the corporation that results from better access to

information and the distribution of resources through the corporation. Additional benefits of client/server include:

- Interoperability – key components (client/server/network) work together.
- Scalability – any of the key elements may be replaced when the need to either grow or reduce processing for that element dictates, without major impact on the other elements.
- Adaptability – new technology may be incorporated into the system.
- Affordability -- cost effectiveness is insured by using less expensive MIPs which are available on each platform.
- Data Integrity –entity, domain and referential integrity are maintained on the database server.
- Accessibility -- data may be accessed from WANs and multiple client applications.
- Performance -- performance may be optimized by hardware and process.
- Security – data security is centralized on the server.

Disadvantages of Client Server

Although client/server computing provides innovative solutions for a number of businesses, it may not be the right solution for all. The flexibility of the client/server systems and the complexity of networking require careful strategic planning up front. Other disadvantages are:

- The hardware, software, and communications technology is neither mature nor entirely stable, nor easy to assemble.
- Because client/server is not well understood it is frequently sold inappropriately or oversold to management and unsatisfied expectations result.
- Support costs can run three times the price of system hardware and software.
- Redesign and reprogramming are not trivial exercises.
- Backup and recovery in a client/server environment can be expensive.
- The more distributed the network, the greater its vulnerability.
- Client/server is an evolving technology and as such there is no standardization.

In theory, client/server looks great; it allows an organization to rapidly create graphical applications that reflect changing business needs. Underneath the surface, however, are unexpected costs that can make client/server systems more expensive to operate that centralized host-based systems are.[22]

2.2.1. Two-Tier Client/Server Application

The two-tiered architecture (refer Figure 2.1) contains two computers -- a client, and a server- with areas of logic combined on the client. The three components of an application- presentation, processing, and data- are divided among two software entities or tiers: client application code and database server. A robust client application development language and a versatile mechanism for transmitting client requests to other server are essential for a two-tier implementation. Presentation is handled exclusively by the client, processing is split between client, and server, and data is stored on and accessed through the server. The PC client assumes the bulk of responsibility for application (functionality) logic with respect to the processing component, while the data base engine- with its attendant integrity checks, query capabilities, and central repository functions- handles data intensive tasks. In a data access topology, a data engine would process requests sent form the clients. Currently, the language used in these requests is most typically a form of SQL. To send the SQL, the client must know the syntax of the server or have it translated by and API (application program interface). Data returned to the client can be manipulated at the client level for further subselection, business modeling, what-if-analysis, and reporting.[22]

- ***Advantages of Two- Tier System***

1. Application development speed is the most compelling advantage of a two-tier environment. In most cases, a two-tier system can be developed in a small fraction of the time it would take to code a comparable but less- flexible legacy system.[21]

2. most tools for two-tier are very robust and lend themselves well to iterative prototyping and rapid application development (RAD) techniques, which can be used to ensure that the requirements of the users are accurately and completely met.
3. Two-tier architectures work well in relatively homogeneous environments with fairly static business rules. They are less suitable for dispersed, heterogeneous environments with rapidly changing rules.[21]

- ***Disadvantages of Two-Tier System***

1. Because the bulk of application logic exists on the PC client, the two-tier architecture faces several potential version control and application redistribution problems, a change in business rules would require a change to the client logic in each application in a corporation's portfolio affected by the change.[21]
2. System security in the two-tier environment can be complicated because a user may require a separate password for each SQL server accessed. The proliferation of end-user query tools can also compromise data base server security.[21]
3. Client tools and the SQL middleware used in two-tier environments are also highly proprietary and the PC tools market is extremely volatile. The volatility of the client/server tool market raises questions about the long-term viability of any proprietary tool and organization may commit to and complicates implementation of two-tier systems.[21]

2.3.2 Three-Tier Client/Server Application

The components of three-tiered architecture are divided into three layers: a presentation layer, a functionality layer, and the data layer. Each of these layers must be logically separate. The three-tier architecture attempts to overcome some of the limitations of the two-tier scheme by separating presentation, processing, and data into separate distinct entities. The same types of tools can be used for presentation as were used in a two-tier environment; however the tools are now dedicated to handling just the presentation. When the presentation client requires calculation or data access, a call is made to a middle-tier functionality server. This tier performs calculations or makes requests as a client to

additional server. The middle-tier servers are typically coded in a highly portable, nonproprietary language such as C. Middle-tier functionality servers may be multithreaded and can be accessed by multiple clients, even those from separate applications. Although three-tier systems can be implemented using a variety of technologies, the calling mechanism form client to server in such a system is most typically the remote procedure call, or RPC (remote procedure call). Because the bulk of two-tier implementations involve SQL messaging and most three-tier systems utilize RPCs, examination of the merits of these respective request/response mechanisms is warranted.[22]

- ***Advantages of 3-Tier***

1. RPC calls form presentation client to middle-tier server provide greater overall system flexibility than the SQL calls made by clients in the two-tier architecture. This is because in an RPC, the requesting client simply passes parameters needed for the request and specifies a data structure to accept returned values.[21]
2. Unlike in most two-tier implementations, the three-tier presentation client is not required to understand SQL. As such, the organization, names, or even the overall structures of the back-end data can be changed without requiring changes to PC based presentation clients. Because SQL in no longer required, data can be organized hierarchically, relationally, or in object format. This added flexibility allows a firm to access legacy data and simplifies the introduction of new data base technologies.[21]
3. Having separate software entities allows for the parallel development of individual tiers by application specialists.[21]
4. Provides for more flexible resource allocation. Middle-tier functionality servers are highly portable and can be dynamically allocated and shifted as the needs of the organization change. Network traffic may be reduced by having functionality servers strip data to the precise structure required before distributing it to individual clients at the local area network (LAN) level.[21]
5. Modularly designed middle-tier code modules can be reused by several applications. Reusable logic reduces subsequent development efforts, minimizes

the maintenance workload, and decreases migration costs when switching client applications.[21]

6. Three-Tier systems such as Open Software Foundation's Distributed Computing Environment (OSF/DCE) offers a variety of additional features to support distributed applications development.[21]

- ***Disadvantages of 3-Tier***

1. Three-Tier brings with it an increased need for network traffic management, server load balancing, and fault tolerance.[21]
2. Current tools are relatively immature and require more complex 3GLs for middle-tier server generation. Maintenance tools have underdeveloped facilities for maintaining server libraries a potential obstacle for simplifying maintenance and promoting code reuse throughout an IS organization.[21]

2.4 Security Consideration

Security refers to the protection of Information System against unauthorized disclosed, alteration or destruction. This involves three features as describe as below:

- Information must always be available at users wish
- Authorized users must be able to do the things they are permitted to
- Integrity of the system must be guaranteed.

Hence, the complete security strategy will include deterrence, protection, detection and response measures.

In the WORS system, ***Secure Socket Layer*** (SSL), ***Transport Layer Security*** (TLS) and ***Wireless Transport Layer Security*** (WTLS) are such a layer protocol that offers privacy and security for the wired and wireless communications.
Figure 2.2 show that the relationship among these three security layer.

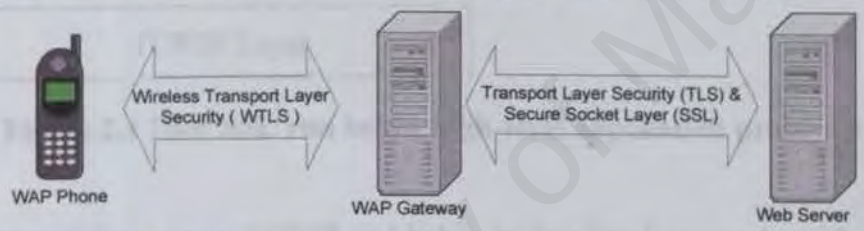

Figure 2.3 WAP session securities

2.4.1 Secure Socket Layer (SSL)

SSL, an open, non-propriety protocol designed by Netscape, is perhaps the most common way of providing encrypted transmission of data between web browsers and web servers (HTTP-S is the runner up)[3]. Built upon private key encryption technology, SSL provides data encryption, server authentication, message integrity, and client authentication for any TCP/IP connection.

2.4.1.1. The SSL Protocol

The Transmission Control Protocol/Internet Protocol (TCP/IP) governs the transport and routing of data over the internet. Other protocols, such as the Hyper Text Transport Protocol (HTTP), Lightweight Directory Access Protocol (LDAP), or Internet Messaging Access Protocol (IMAP), run "on top of" TCP/IP in the sense that they all use TCP/IP to support typical application tasks such as displaying web pages or running email servers.

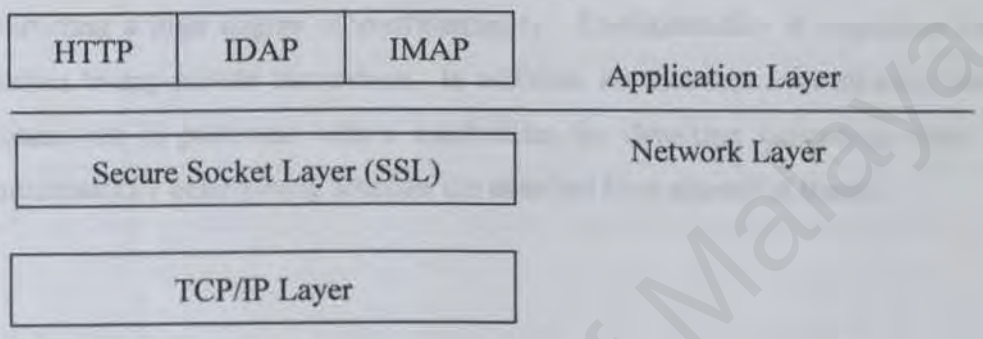

Figure 2.4 How SSL run below high-level application protocols

The SSL protocol runs above TCP/IP and below higher-level protocols such as HTTP or IMAP. It uses TCP/IP on behalf of the higher-level protocols, and in the process allows an SSL-enabled server to authenticate itself to an SSL-enabled client, allows the client to authenticate itself to the server, and allows both machines to establish an encrypted connection.[1]

These capabilities address fundamental concerns about communication over the Internet and other TCP/IP networks:

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

- **SSL client authentication** allows a server to confirm a user's identity. Using the same technique as those used for server authentication, SSL-enabled server software can check that a client's certificate and public ID are valid and have been issued by a CA listed in the server's list of trusted CAs. This confirmation might be important if the server, for example, is a bank sending confidential financial information to a customer and wants to check the recipient's identity.

- **An encrypted SSL connection** requires all information sent between a client and a server to be encrypted by the sending and decrypted by the receiving software, thus providing a high degree of confidentiality. Confidentiality is important for both parties to any private transaction. In addition, all data sent over an encrypted SSL connection is protected with a mechanism for detecting tampering—that is, for automatically determining whether the data has been altered in transit.

2.4.2. Wireless Transport Layer Security (WTLS)

Wireless Transport Layer Security, or WTLS, provides the main security elements of WAP communications.

It is by using the WTLS protocol that we can achieve some measure of authentication and confidentiality in wireless applications. As mentioned earlier, WTLS is the wireless version of the industry standard Transport Layer Security (TLS), which is equivalent to the widely used SSL security protocol.

The Internet's TLS establishes a secure network connection session between a client and a server, typically between a Web browser and a Web server. WTLS provides a secure network connection session between a WAP device and a WAP gateway. WTLS was developed because of the special needs of the high-latency, low-bandwidth wireless environment.

The kernel of WTLS security is in the Wireless Identity Module (WIM). The WIM performs the optimized cryptography during the handshaking process, especially for client authentication, and forges long-term, secure WTLS connections.

WTLS can initiate a secure session by using an optimized handshake with dynamic key refreshing. Dynamic key refreshing allows encryption keys to be updated on a regular and configurable basis during a secure session. This not only provides a higher level of security, but also provides significant bandwidth savings on the relatively costly handshaking procedure.

2.4.2.1. The WTLS Protocol

The ***WTLS protocol*** is composed of three layers: the Handshake Protocol layer, the Change Cipher Spec Protocol layer, and the Alert Protocol layer.

a) **The Change Cipher Spec Protocol**

The Change Cipher Spec is sent to peer either by the client or the server. When the Change Cipher Spec message arrives, the sender of the message sets the current write state to the pending state and the receiver also sets the current read state to the pending state. The Change Cipher Spec message is sent during the handshake phase after the security parameters have been agreed on. [12]

b) **The Alert Protocol**

The Record Protocol also provides a content type of alert messages. There are three types of alert messages: warning, critical, and fatal. Alert messages are sent using the current secure state, i.e. compressed and encrypted, or under null cipher spec, i.e. without compression or encryption.

If the alert message, labeled as fatal, is sent, then both parties terminate the secure connection. Other connections using the secure session may continue but the session identifier must be invalidated so that the failed connection is not used to establish new secure connections.

A critical alert message results in termination of the current secure connection. Other connections using the secure session may continue and the secure identifier may also be used for establishing new secure connections.

The connection is closed using the alert messages. Either party may initiate the exchange of closing messages. If a closing message is received, then any data after this message is ignored. It is also required that the notified party verifies termination of the session by responding to the closing message.

Error handling in the WTLS is based on the alert messages. When a error is detected the detecting party sends an alert message containing the occurred error. Further procedures depend on the level of the error that occurred. [12]

c) **The Handshake Protocol**

All the security related parameters are agreed on during the handshake. These parameters include attributes such as used protocol versions, used cryptographic algorithms, information on the use of authentication and public key techniques to generate a shared secret. The flow chart of the handshake is depicted in Figure 2.4.

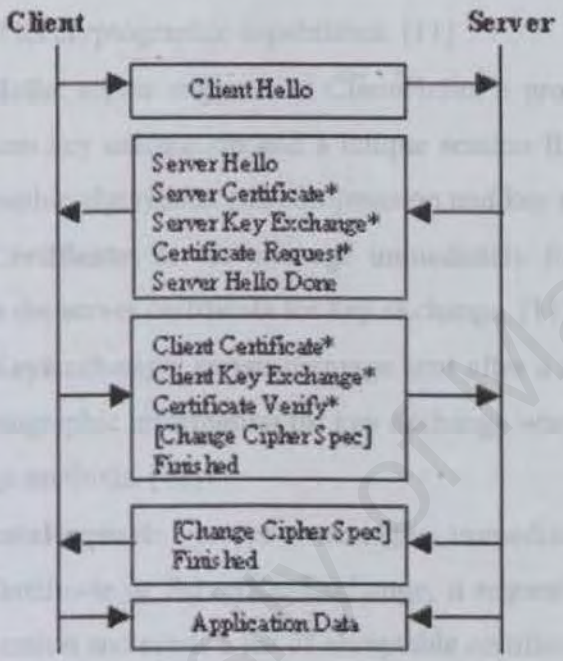

Figure 2.5 Full Handshake Flow Chart [12]

First, the client and server exchange hello messages, which is where they agree on algorithms. Then they exchange the necessary cryptographic parameters, and certificates.

Some of the details of the exchanged messages are as follows:

- **ClientHello**: first message client sends when connecting to server, it initiates a secure connection, provides random number for session key calculation, optionally identifies which session to resume and tells the server of its cryptographic capabilities. [11]
- **ServerHello**: server response to ClientHello, it provides a random number for session key calculation and a unique session ID, as well as selects the cryptographic algorithms and compression and key refresh options. [11]
- **ServerCertificate**: server message immediately following ServerHello, it provides the server certificate for key exchange. [11]
- **ServerKeyExchange**: server message sent after a ServerHello, it provides the cryptographic information for key exchange when using anonymous key exchange methods. [11]
- **CertificateRequest**: server message immediately following either ServerCertificate or ServerKeyExchange, it requests a certificate for client authentication and sends a list of acceptable certificate authorities. [11]
- **ServerHelloDone**: server message that indicates the end of the ServerHello related messages, telling the client it can now proceed with its key exchange messages. [11]
- **ClientCertificate**: client message following a ServerHelloDone if the server requested a client certificate, it provides the client certificate for authentication. [11]
- **ClientKeyExchange**: client message following ClientCertificate, it sets the pre-master secret through either through direct transmission of the RSA-encrypted secret or by transmission of the Diffie-Hellman public key. [11]
- **CertificateVerify**: client message following ClientKeyExchange if the client has signing ability it provides explicit verification of the client certificate. [11]

- **Finished**: sent by both client and server at the end of the handshake, it verifies a successful key exchange and authentication process, and is the first message that is actually protected by the agreed-upon methods. [11]

An abbreviated handshake is when a ClientHello includes a session ID of a secure session to be resumed and the server agrees to reestablish the connection. An optimized handshake occurs when the server looks up the client certificate from its own source rather than requesting from the client. [11]

2.4.3. Transport Layer Security (TLS)

The **Transport Layer Security (TLS)** protocol is based on and similar to SSL and is a draft standard of the IETF. Its primary goal is to provide privacy and data integrity between two communicating applications. It consists of two layers. The lower level is termed the TLS Record protocol and is layered on top of some reliable transport protocol, such as TCP. This layer has two basic properties specifically that the connection is private and that it is reliable. It is used for encapsulation of various higher level protocols but can also be used without encryption. Where encryption is used, as would be normal, the secret keys for this are generated uniquely for each connection and are based on a secret key negotiated by another protocol, such as the higher level TLS Handshake protocol.

The TLS Handshake protocol provides connection security that has three basic properties, namely that the peer's identity can be authenticated using asymmetric cryptography, that the negotiation of a shared secret is secure, and that the negotiation is reliable.

As with SSL, TLS is application protocol independent and uses a similar range of ciphers. The TLS standard, however, leaves the decisions on how to initiate TLS handshaking and how to interpret the authentication certificates to the judgment of the designers and implementers of the protocols that run on top.

The goals of the TLS protocol are cryptographic security, interoperability, and extensibility, in that order of priority. The last of these goals means that TLS provides a framework into which new and improved asymmetric and other encryption methods can be introduced as they become available. [9]

2.5 Server Platform

2.5.1 UNIX

Unix is an increasingly popular operating system and it is traditionally used on minicomputers and workstations in the academic community. Unix is now available on personal computers and the business community has started to choose Unix for its openness.

Unix can run on multiple platforms and the minimum requirements are vary depending on platform chosen. There are several advantages about Unix that enables it to become one of the popular operating system among large organization. These include [23]

- High reliability

Unix is extremely robust because the new file system optimizes disk input and output (I/) for high performance. It also ensures reliability for transation based application such as databases.

- High performance

Unix is the choice for high performance network applications. It will outperform other operating systems when running on equivalent hardware. Unix is used by Yahoo, USWest and Xoom.com as their main server's operation system because of is ability to handle heavy network traffic with high performance.

- Good development environment

Unix includes an extensive collection of development tools such as C/C++, Java, HTTP, Perl and Python. All of these are free, come with full source code and are included in the installation.

Although Unix can be considered one of the popular operating system, but it also have a few disadvantages such as [12]

- Expensive

Unix is very expensive compared to other operating systems, besides that, all Unix machine are also very expensive because it is specially designed only for Unix.

- User unfriendliness

The interface in Unix is based on command-line interface (CLI) and it requires user to type specific command in order to execute any applications or instructions. Many users are not familiar with CLI, so it is quite difficult for them to use Unix. Although Unix had developed a few graphical user interface (GUI) but it is still not as complete and friendly as the Windows desktop.

- Installation problem

Many users will face problem during installation because the installation process needs the concept of disk partitioning and mounting of file systems, which are relatively an advanced concept for new users. The users also have to know the details of the graphics adapter card and monitor in order to provide the information the installation program requires.

- Difficult to configure and maintain

Unix is difficult to configure and maintain because it requires the users to type a set of specific commands for configuration and maintenance. The configuration is not guided with any wizard or GUI interface.

2.5.2 OS/2

OS/2 was the operating system that developed by IBM. He benefits of having OS/2 are [24]:

- High productivity

The two main concerns of computer users are having their system available and having a simpler way to do their work. OS/2's voice-enabled, Internet-aware desktop introduces the next generation east of use and combines with rock solid dependability to maximize productivity.

- Openness

OS/2 can support for industry standards such as Common Object Request Broker Architecture (CORBA) and System Object Model (SOM) and also provide excellent multivendor interoperability and flexibility.

- Excellent in technical support

OS/2 offers the best overall technical support and online support in WWW. It also offers an excellent phone support that significantly exceeded Microsoft's phone support.

However OS/2 also has several weaknesses [24]:

- Limited application support
- Average reliability
- Poor usability

2.6 Web Servers

2.6.1 Apache web server

Apache server is a powerful yet flexible web server. It is compliant with HTTP/1.1 and implements the latest protocols, including HTTP/1.1 (RFC2616) . Apache web server is highly configurable as it is in open source code and extensible with third-party modules, and can be customized by writing 'modules' using the Apache module API. Moreover, it provides full source code and comes with an unrestrictive license.

Apache web server runs on Windows NT/9x, Netware 5.x, OS/2, and most versions of Unix, as well as several other operating systems. The web server is actively being developed and encourages user feedback through new ideas, bug reports and patches. The features of Apache web server include DBM databases for authentication, customizable responses to errors and problems, multiple DirectoryIndex directives and unlimited flexible URL rewriting and aliasing. It is compatibles with Windows 2000, NT, Linux, NetWare 5.0 (with Service Pack 5), 5.1 (with Service Pack 1), UNIX, BSD, HP MPE/iX 6.0 or higher and TPF version 4.1 PUT09.

However, there are limitations in Apache Web Server. To corporate Web server customers, the fact that Apache is free can be a drawback, signifying a lack of the explicit or implied accountability they get with vendor products. Its flexibility also can be a double-edged sword. Apache is easy to set up, but those who try to extend it had better know what they are doing. Where there is not a lot of expertise available, customers may also prefer to see features that come together and have been tested together rather than search them out from multiple sources on the Internet. The lack of software support for Apache that has been a stumbling block to its adoption by business users also is beginning to be remedied. Traditionally, Apache support has been confined to online resources. [26]

2.6.2 Microsoft Internet Information Server (V.5.0)

Internet Information Services 5.0 (IIS) is the Windows 2000 Web service that makes it easy to publish information on the intranet for the Internet. It is completely integrated with Windows NT Directory Services and includes Crystal Reports, a visual reporting tool. Internet Information Server 5.0 has many new features to enables user to create a scalable and flexible web applications. It allows administrators to configure servers, sites, virtual directories, subdirectories and files individually. It also includes crash protection that allows users to run multiple applications reliably. Moreover IIS includes tools to analyze and manage web server content and supports multiple webs sited on one IP address.

2.6.3 Netscape Enterprise Server

The Enterprise Server is a high performance, enterprise-strength web server. It provides supports HTTP 1.1 protocol, a built-in search engine with documents attributes and custom views, advanced content publishing and management for end users through an approach called "Netshare", server clustering and administrative rights delegation and Java integration with support for JavaBeans, JDBC and servlets. It can support a variety of platforms such as Windows NT, UNIX, IRIX, AIX, HPUX and others.

Netscape Enterprise Server provides end-users the ability to manage their own content. "Net share" a built-in tool facilitates group collaboration as multiple users may publish pages to a server, edit, share, collaborate on creating a document and control access to their documents without needing a system administrator to intervene. With its centralized server management capability, it enables large organizations to manage its large number of users more effectively.

However, Netscape Enterprise has several drawbacks. Due to its insufficient GUI-based interface, it is difficult to configure. Users are facing difficulty in getting support as the only way to get technical support is through mailing lists.

2.7 Database

2.7.1 Microsoft Access 2000

Microsoft Access provides users with one of the simplest and most flexible DBMS solutions on the market today Regular users of Microsoft products will enjoy the familiar Windows "look and feel" as well as the tight integration with other Microsoft Office family products. An abundance of wizards lessen the complexity of administrative tasks and the ever-present Microsoft Office Helper is available for those who care to use it. Against other desktop database packages Access has one huge advantage. Access integrates well with Microsoft Office packages and data transfer between Access and the other Office components is relatively easy.

In addition, against the other desktop databases Access is both rich in features and powerful. Microsoft Access is a desktop database package. It is not designed to compete with systems such as Oracle or SQL Server - full database servers - whose engines are superior in terms of speed and multi-user capabilities. Microsoft Access is a relational database. This type of database has a much more complex design which, in turn, offers much more functionality and power. The downside is that an effective relational database needs to be designed properly.

Some of the features and the advantages that Microsoft Access poses are as followed:

- Making Information Easy to Find and Use
  Access 2000 continues to offer an easy-to-use tool for easily finding information that provides consistency and integration with the other applications in the Office suite.

- Web-Enabled Information Sharing
  Access 2000 allows easily sharing information via the corporate intranet and the ability to easily host a database within the browser. This combines the power of a desktop database with the power of the web.

- Powerful Solutions Tools for Managing Information

  Power users and developers may now create solutions that combine the ease-of-use of the Access interface (client) with the scalability and reliability of SQL Server.

- User-friendly forms interface

  Microsoft Access allows users to enter information in a graphical form and have that information transparently passed to the database. This method is less intimidating for the data entry operator but requires a little more work on the part of the database administrator.

- Generating of summaries.

  Reports provide the capability to quickly produce attractively formatted summaries of the data contained in one or more tables and/or queries. Reports allow the inclusion of graphics, attractive formatting and pagination.

2.7.2 Oracle

Oracle platform is available for multiple operating systems and research proved that Oracle runs great on Unix. Oracle is more standards-based as well with a set of neat features. Oracle databases are as powerful as the users want them to be. Oracle also is able to efficiently utilize hardware platform that and manage multiple high-speed processors, clustered servers, high bandwidth connectivity and fault tolerant storage technology. Java application can run perfectly with combination of Oracle database.

Oracle also provided the users with more power and flexibility with the database to meet the user requirements. Oracle able handles a rapidly expanding amount of users and/or data gracefully.

One of the disadvantages is Oracle has weird concepts and names as well. As a result, users have to be undergoing specialized training/knowledge to be more familiar with Oracle database management; even the experts of other DBMS, like Microsoft SQL Server and Microsoft Access. Besides, Oracle needs a costly start-up solution of database management. Besides, total of ownership is high for Oracle

2.7.3 Microsoft SQL Server 7.0

Microsoft SQL Server 7.0 offers a solution that's aimed at rapid development and low-cost implementation. Microsoft SQL Server 7.0 run limited on Windows based platform. Built-in Internet integration allows users to conduct business on the Internet and build intranet sites. Microsoft SQL Sever 7.0 has increased many fronts depending to the previous versions, and terabyte database are supported. SQL Server 7.0 leads in price-performance by reducing administrative overhead and lowering total cost of ownership with a design that is geared toward dynamic configuration.

Many of the day-to-day manual tasks of the database administrator have been automated. Dynamic locking, dynamic memory allocation, auto-grow tempdb, auto-grow log files, auto-grow database files, automatic creation of the database upon a restore, automatic index creation across an entire database, and many other new features help eliminate administrative tasks. Microsoft SQL Server 7.0 minimizing complexity for users, administrators, and developers allows application to be deployed at a lower cost and in less time.

The most significant advantage of the Microsoft SQL server is the wide variety of third party client support client support available, from those designed strictly for application development to add-in SQL server access modules for standard PC-based DBMSs such as Paradox and dBASE. There are even access modules that let users query the database from leading spreadsheet program. [Joe Salemi, Guide to Client/Server Databases, Ziff-Davis Press, Second Edition, 1995].

Some of the Microsoft SQL Server's features and advantages are listed in the following:

- ***Easy access to data through the Web***

  Users can use HTTP to send queries to the database, perform full-text search on documents stored in database, and run queries over the Web with natural language.

- ***Highly Scalable and Reliable***

  SQL Server with scale up and scale out capabilities meets the needs of demanding e-commerce and enterprise applications.

- ***Integrated and extensible analysis services***

  Users can build end-to-end analysis solutions with integrated tools to create value from data. Additionally, users can also automatically drive business processes based on analysis results and flexibly retrieve custom result sets from the most complex calculations.

- ***Simplified management and tuning***

  It is easy to manage databases centrally alongside all enterprise resources. Stay online while easily moving and copying databases across computers or between instances.

- ***Quick development, debugging, and data transformation***

  SQL Server features the ability to interactively tune and debug queries, quickly move and transform data from any source, and define and use functions. Users can visually design and code database applications from any Visual Studio tool.

2.8 Programming Language

2.8.1 Java

At the heart of all the Java talk is the Java programming language. Java is an object-oriented programming (OOP) language that uses many common elements from other OOP languages, such as C++, but it adds some enhancements to make programming Java easier. Like any other language, Java has a particular syntax, a structure for programs, and many supporting applications. The Java Developer's Kit (JDK) contains all of the tools necessary to create applications (or Web applets) using the Java programming language.

Java is largely based on the C++ programming language. Also, Java is designed to include the functions of a high-level programming language while eliminating some of the more difficult aspects of coding in C++. Java objects are also designed to make programming easier. Everything in Java is based on the object model. This functionality was deliberately built in Java to help speed up Java development in the long run.

According to Sun Microsystems, Java is "simple, object-oriented, statically typed, compiled, architecture neutral, multi-threaded, garbage collected, robust, secure, and extensible. The following will list out some of the Java's attributes and advantages:[19]

- ***Simple***

  The simplicity of Java is enhanced by its similarities to C and C++. Java has simplified C++ programming by both adding features beyond those found in C++ and by removing some of the features that make C++ a complicated and difficult language to master. Java is simple because it left out many of the unnecessary features of other high-level programming languages

- ***Object-oriented***

  In its approach to object-orientation, Java follows more closely along the lines of languages such as SmallTalk than C++. . Just like C++, Java uses classes to organize code into logical modules. At runtime, a program creates objects from the classes. Java

classes can inherit from other classes. Except for its primitive data types, everything in Java is an object. Java's support for object-orientation does not include multiple inheritances.

- ***Multi-threaded***

A multithreaded program is one that is written such that it performs more than one task at a time. Java programs can contain multiple threads of execution, which enables programs to handle several tasks concurrently. All applications have at least one thread, which represents the program's main path of execution.

- ***Robust***

Because the Java interpreter checks all system access performed within a program, Java programs cannot crash the system. Instead, when a serious error is discovered, Java programs create an exception. This exception can be captured and managed by the program without any risk of bringing down the system.

- ***Secure***

Closely related to Java's robustness is its focus on security. Because Java does not use pointers to directly reference memory locations, as is prevalent in C and C++. Therefore, programs cannot gain access to areas of the system for which they have no authorization. Thus, Java has a great deal of control over the code that exists within the Java environment.

- ***Platform Independent***

Platform independence is another way of saying that Java is architecture neutral. Platform independence is the capability of the same program to work on different operating systems; Java is completely platform independent. This means that Java programs don't care what system they're running on.

2.8.2 Microsoft Visual Basic 6.0

Visual Basic 6.0 is one of the products in Microsoft Visual Studio Package. It allows users to develop Windows application quickly and easily without being expert in other programming languages. Visual Basic provides a graphical environment in which user can visually design the forms and controls that building blocks of applications.

Visual Basic supports many tools, especially to build 3-D Windows "look and feel" interface that will help users be more productive. The tools are not limited to, projects, forms, class objects, templates, custom controls, add-ins, and database managers, users also can use the tools together to create complete applications in months, weeks, or even days; producing an application using another language can take much longer.

Some of the Visual Basic 6.0's features and advantages are as followed:[17]

- Easy to use and has fast development period.
- Visual Basic 6.0 provides more of the actual code for a programmer than any other non-visual programming language.
- The built-in interface creation capability furthers the standardization on the user interface to Windows applications.
- Saving the users' time by eliminating time spent for writing code to create the user interface to his applications (the visual interface).
- Tools that perform a full range of development tasks.
- Templates (code, property, control) that allow users to reuse code, control property sets, and entire controls with their associated code.
- An enhanced design time environment. The IDE Function Library gives the users instant working code. And the formatter object and expanded Object browser provides users access and work with code in new, innovative, and faster ways.
- A macro facility that lets users to create their own tools without the overhead of the VB6 Add-in Model.

2.8.3 C++

In the early 1980, Bjarne Stroustrup at AT&T Bell Laboratories designed C++ as an extension to the C language, providing data abstraction and object-oriented programming facilities. Stroustrup designed the language to remain compatible and comparable with C in terms of syntax, performance and portability. The C++ language provides key capabilities and benefits offered by object-oriented programming. C++ excludes features that would constrain its use to a limited set of application domains and environments. The mechanisms are defined to allow highly efficient implementations and versatility offered by the language.

Some of the C++'s features and advantages are listed below:[25]

- ***Object-oriented programming***

  The possibility to orientate programming to objects allows the programmer to design applications from a point of view more like a communication between objects that on a structured sequence of code. In addition it allows the reusability of code in a more logical and productive way.

- ***Portability***

  The same C++ code can be compiled in almost any type of computer and operating system without making changes. It is obvious that C++ is one of the most used and ported to different platforms programming language.

- ***Brevity***

  Code written in C++ is very short in comparison with other languages, since the use of special characters is preferred before key words, saving effort (and prolonging the life of our keyboards).

- ***Modular programming***

  An application's body in C++ can be made up of several source code files that are compiled separately and then linked together. Saving time since it is not needed to

recompile the complete application when making a single change but only the file that contains it. In addition, this characteristic allows to link C++ code with code produced in other languages like Assembler or C.

- ***Speed***

The resulting code from a C++ compilation is very efficient, due indeed to its duality as high-level and low-level language and to the reduced size of the language itself.

2.9 Similarity System Review

Analysis to the similar system is a key study about the knowledge and information gained to develop this project. The purpose is to provide a better understanding to the features and development tools that can be integrated in my proposed system.

Apart from that, the analysis enables to comparing on the strength and weakness of the each similar system. It will also give an overview of how to improve the weaknesses and in advance of the existed features.

2.9.1 Restaurant Coffee Terrace at Genting Highlands

Restaurant Coffee Terrace is a restaurant which is operated by Micros POS system. The restaurant will use a static terminal POS to enter the order. Before insert any order, the waiter and waitress may using a pen and paper (like manual system) to serve with customers. The features and some strength and weaknesses about this system are shown as below:

Restaurant Coffee Terrace		
Features :	(√)	User Login & Password Authentication
	(√)	Routes orders to kitchen & bar
	(√)	Item modifiers
	( )	Inventory Control
	(√)	Central POS system
	(√)	Printing Receipt
	(√)	System Administrator
	(√)	Payment Process
	(√)	Management Report

( )	Reservation purpose
(√)	Authorize credit cards
( )	Wireless Pos Terminal
(√)	Wired Pos Terminal
(√)	Order by table and seat number
( )	Kitchen or bar display system
(√)	Touch Screen Display (Graphical User Interface)
(√)	Routes orders to designated printers
(√)	Graphical table management

Table 2.1 Analysis of Restaurant Coffee Terrance

There are several weaknesses abut this system. The details are shown as below:

1. **Centralize Payment System**

   The system only support for centralizing payment in central POS machine. The weakness is that no flexibility about the system. The customers have to go to counter to make a payment.

2.9.2 21st Century Restaurant System

AMERANTH Wireless is a leading provider of wireless system software to the hospitality and health care markets. Headquartered in San Diego, California, Ameranth's wireless systems software gives functionality to RF enabled Pocket PC handheld computers—moving the point of activity from fixed terminals to where it belongs, by the customer's side. Ameranth's **21st Century Restaurant** is set to become the industry standard for mobile wireless ordering and payment processing in restaurants.

Ameranth's 21st Century Restaurant		
Features :	(√)	User Login & Password Authentication
	(√)	Routes orders to kitchen & bar
	(√)	Item modifiers
	( )	Inventory Control
	(√)	Central POS system
	(√)	Printing Receipt
	(√)	System Administrator
	(√)	Payment Process
	(√)	Management Report
	( )	Reservation purpose
	(√)	Authorize credit cards
	(√)	Wireless Pos Terminal
	( )	Wired Pos Terminal
	(√)	Order by table and seat number

( )	Kitchen or bar display system
(√)	Touch Screen Display (Graphical User Interface)
(√)	Routes orders to designated printers
( )	Graphical Table Management
( )	Back Office Accounting

Table 2.2 Analysis of the Ameranth's 21st Century Restaurant

There are several weaknesses about this system. The details are as below:

1. **Unfriendly user interface**

   Although the interface design is very attractive but the interface content is very confusing. For example, there has too many button linkers in a single page and the buttons have no detail description.

2. **No help menu**

   This system does not provide a help menu for user to reference especially for describe to the each button linker.

There are several strengths about this system. That is:

1. **Wireless Pos Terminal (wireless ordering system)**

   The system is using handheld computer to serve to the customer and the benefit is providing of satisfaction to the customer.

2. **Wireless Payment Printer**

   Receipt may be generating right at the table.

2.9.3 Exece/Touch

Execu/Tech Systems began in December, 1981. As a software development company specializing in hotel, restaurant point of sale, and real estate property management software.

		Execu/Touch
Features :	(√)	User Login & Password Authentication
	(√)	Routes orders to kitchen & bar
	(√)	Item modifiers
	(√)	Inventory Control
	(√)	Central POS system
	(√)	Printing Receipt
	(√)	System Administrator
	(√)	Payment Process
	(√)	Management Report
	( )	Reservation purpose
	(√)	Authorize credit cards
	(√)	Wireless Pos Terminal
	( )	Wired Pos Terminal
	(√)	Order by table and seat number
	( )	Kitchen or bar display system
	(√)	Touch Screen Display (Graphical User Interface)

(√)	Routes orders to designated printers (Kitchen & Bar)
(√)	Graphical Table Management
(√)	Back Office Accounting

Table 2.3 Analysis of the Execu / touch system

2.10 Summary of Chapter 2

All the research was done mainly to gain information for this project. The information gathered includes WAP technology, client-server architecture, security consideration, server platform, web server, and review on the similar system.

As for the WAP technology, the review of literature is base on the WAP architecture and WAP layers. In the WAP architecture, it is concentrate on the way to send and receive data in between mobile user and web server. It is found that WAP architecture is similar to the traditional web application but WAP architecture must have a WAP gateway which acts as an interface in between the TCP/IP world and the mobile phone. In the other hand, WAP layers contain a session protocol, a transaction protocol, a security protocol, and a data gram protocol. And each layer has some tasks to perform. In the application layer, the Wireless Markup Language (WML), WML script, WML script virtual machine and Wireless Telephony Application will be consisted. Therefore, there are two type of session layer consist which are Wireless Session Protocol (WSP) and Wireless Transport Layer Security (WTLS). In the Transport layer, Wireless Transport Protocol (WTP) and bearer services provide reliable transmission of WSP data packets between the client and server over a wireless link

In the client-server architecture review, advantages and disadvantages have been list out. Besides, comparisons have been made between 2-tier client/server technology and 3-tier client/server technology and each technology advantages and disadvantages are also reviewed.

Besides that, some research was carried out to gather information on the security aspect for this system. The security aspects include the Secure Socket Layer (SSL), Wireless Transport Layer Security (WTLS) and Transport Layer Security (TLS).

The information gathered on development tools for the project was analyzed. In the server platform, the analysis is based on the UNIX, Microsoft Windows 2000 and OS/2. Each Platform has its strengths and weaknesses. The web server been studied were Apache web server, Microsoft Internet Information 5.0 and Netscape Enterprise Server. The development tools chosen for this project will be mention in the next chapter.

Finally, the reviews on the similar system were done in order to complete the process of literature review. The research was done by observing and browsing to internet to gain the information of the features of the similar system. The weaknesses on the similar system were identified in order to overcome the current system.

CHAPTER 3

METHODOLOGY & SYSTEM ANALYSIS

CHAPTER 3

METHODOLOGY & SYSTEM ANALYSIS

Chapter 3: Methodology & System Analysis

3.1 Methodology Approach

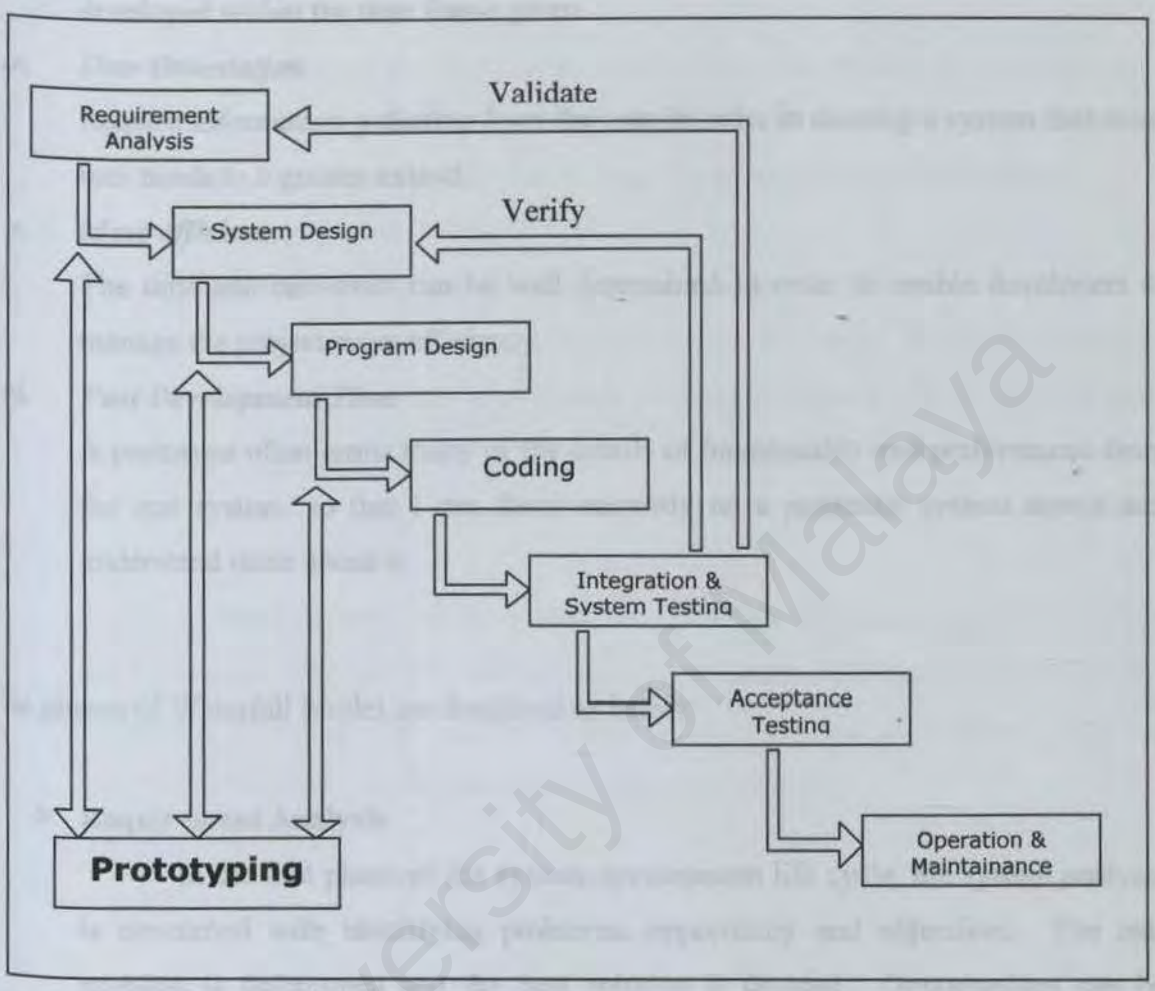

Figure 3.1 Waterfall Model

In order to develop a system or to make a project successful, an approach must be chosen. I had chosen the *Waterfall Model with Prototyping* as methodology for developing my project because of the following reason:

i. ***Good Visibility***

Waterfall Model produces a high level view of what goes on during development and it suggests the sequence of events they should expect to encounter. With the good visibility enables the ease to generate documentation for each activity.

ii. ***Very structure***

The system is design using a logical flow.

iii. ***Predictable***

It allows estimation of the completion of each stage so that the system can be developed within the time frame given.

iv. ***User Orientation***

Require information gathering from the user in order to develop a system that meet user needs to a greater extend.

v. ***More efficient***

The time and resources can be well determined in order to enable developers to manage the project more efficiency.

vi. ***Fast Development Time***

A prototype often omits many of the details of functionality and performance from the real system, so that I can focus narrowly on a particular system aspect and understand more about it.

The phases of Waterfall Model are described as below:

- **Requirement Analysis**

In the first phase of the system development life cycle, the system analysis is concerned with identifying problems, opportunity and objectives. The real problem is determined and the best solution is decided. Opportunities can be conceived of as the observation of the problem, and improvement can be defined as changes that will result in increment yet worthwhile benefits. Then the specification and the constraints of the project can be determined to define information requirement.

- **System and Program Design**

In this phase, the systems analyst uses the information collected earlier to accomplish the logical design of the system. The analyst will design accurate data-entry procedures so that data going into the system are correct. Besides that, the

system analyst also has to design the files or database that will store much of the data needed. The design description and the modules specs are written in this stage.

- **Coding**

  During this phase, the original software is developed. .Each program is called a unit, and unit testing is the verification that every unit meets its specification. All the units combine to form a large unit that is called system.

- **Integration and System Testing**

  Before the system can be used, it must be tested. It is much less costly to catch problems before the system is signed over to users. A series of tests to pinpoint problems is run first with sample data and eventually with actual data from the current system.

- **Operation & Maintenance**

  In this last phase of the system development, activities included are using the system, fix the problems and enhance the program. This process also includes converting files from old formats to new ones or building a database, installing equipment and bringing the new system into production.

3.2 Information Collection Techniques

Effective development of a project depends on thoroughly planning and extensively analysis of the project. In order to gather valuable information, I had chosen two techniques which are used to define the system requirement. The techniques are described as follow:

3.2.1 surfing to the internet

Internet surfing is a very efficient way in order to gathering information. Form the internet, I can obtain the latest and updated information which is required in my system. Besides, I also browse to the internet to find out some system which is similar to my system.

3.2.2 Observation

To find out how the effectiveness the restaurant POS system operate, I choose to observe and analysis some existing systems which are similar to my system. I plan for my system requirements according to the analysis I had made so that to have a complete system that integrating the positive value of functions and features those existing sites have.

3.3 Requirement Analysis

This covers the aspect of the functional requirement and non-functional requirement of this system.

3.3.1 Functional Requirements

Functional requirement describes an interaction between the system and its environment. Further, functional requirement describe how the system should behave in particular situation. In some cases, it also stated what the system should not do. And it is independent from the implementation of the solution.

There are six important functional for this project. These involve:

- Ordering process
- Payment process
- Mobile Reservation process
- Generate Management Report
- Kitchen and Bar Display system
- Pre-set Food Menus and Modification in the system
- POS Administrator

7.2.1

i. **Ordering Process**

When ordering is performed, a floor server will using wireless handheld computer to taking the order for customer. The server will touch the button on the menu screen according to the item have been ordered. The menu screen divides into two categories which are food and drink.

In the ordering process, the server will key in the table number and number of seats. Then, the server will directly take down the order. Finally, the server will touch a send button which means the order process is done.

The system will upload the list of order from wireless handheld computer to the application server to process it. Then the application server will send the order

immediately to kitchen and bar display system according to the order item and save the order item into database.

Besides, for hospitality purpose, the systems allow the customer to add new item and cancel the ordered item. Canceling the item will be performed if the item have not prepared by the kitchen or bar.

ii. **Payment Process**

Once the customer calling for bill, floor waiter will directly show the ordered item and the total to the customer with their handheld computer. Then the customer can choose either pay by cash or credit card. If the customer pays by cash, the server just key in the amount and send to the cashier and the cashier will print out a receipt and prepare the change to the server. And the cashier will close the account.

iii. **Mobile Reservation Process**

For this function, the system will allow customer using their mobile phone to access to a specific URL to make a reservation. In the reservation process, the customer has to log on to the system. A login authentication is a gateway for registered customer who wants to make a reservation. Besides, unregistered customer can join the membership offered. The customer who has been signed has to select date, time, number of table and number of seat for reservation purpose.

iv. **Generate Management Report**

The system will generate the sales related reports which are restaurant sales reports, item sales reports, server sales reports, payments reports, void reports, time and attendance reports, profitability reports, and table turn reports.

These reports will be generated base on the data that is kept in the database. And the reports can generate by day, week, month and year.

v. **Kitchen And Bar Display System**

After the ordering process, the kitchen display will automatically display the item ordered. When the chef or bar tender prepare the ordered item, they have to touch the preparing button on the screen to make cancel item function malfunctioning. When the

food or drink is ready, the chef or bar tender has to touch "ready" button to inform floor server to deliver it. Besides, the bar or kitchen has a function that informing the server which item is out of stock.

vi. **Pre-set Food Menus and Modification in the system**

In preset the food menu, this system need authorize top management to update. This is by which the manager will need login account to access the system database. However, once this task is taken, the system will automatically pop up the menu for the manager to select and update. This menu is flexible, which the manager can select for add, delete or modify for the particular categories item. The category item can be the food, drink or dishes.

Once this operation is performed from the system, it will automatically updated and all the waiter or waitress that using the palm handheld computer will receive the same food menu.

In terms for the modification part, it also needed access and performed by the top management. There is needed for the manager to login their account first before access to the system and update the database. Once access to the system, the manager need to select the meal first and then change the price for that meal in order to changing the price for the particular meal.

On the other hand, once the manager wants to add new meal to the system, they can add and then update to the system database. Once updated to the database, the waiter or waitress will access such new meal from their palm handheld computer.

vii. **POS Administrator**

This function allows a super user have a right to manage the system. This includes canceling and modifying the order that have mistaken by floor server.

3.3.2 Non Functional Requirements

Non-functional defines system constraints on a system that limit choice for constructing a solution to the problem. The non-functional requirements are as below:

- ***Speed***

  It should at least process a transaction successfully in thirty seconds to provide an efficient online used bookstore system. Interaction between the server and the client that is inessential will increase the response time. Therefore, to have a fast response time, some of the validation will be done in the client side by using the client side scripting language.

- ***Reliability***

  The system must has the ability to always behave without deviation from its specifications when running under conditions consistent with that specification as well as be able to function smoothly even in an irregular situation. Besides, it also ensures that the data in the database would not be damaged, but keep intact in the database. Therefore, the system is reliable to use without dangerous affects.

- ***Correctness***

  This is referring to the extent to which the program satisfies its specification and fulfils the future needs.

- ***Usability***

  Appropriate user interface and sufficient documentation will lead to the usability of the system. The system will provide a user-friendly graphical user interface. The system will using a touch panel screen and the user just have to touch on the screen the order they needed.

- ***Modularity***

  This is a key factor to good programming. The system was decomposed from higher level into lower level modules so that distinct functions of objects could be

isolated from one another. This characteristics makes testing and maintenance much easier.

- ***Maintainability***

This refers to the modification and updating of a program or procedure in the system. To have maintainability, the system should require just a minimum number of steps and it does not comprise of complicated functions or procedures.

Its function or interfaces can be improved or enhanced easily from time to time without complex coding or programming

- ***Security***

This system will have security access to login into the system. Each user will have a different identity to log on the system. Different level of user will have different authority level of accessibility.

➢ **Accuracy**

The system is able to keep the data accurate and up-to-date all the times. When there is any changes occur in one module, the system will automatically update that information in all the others related modules. Besides, any duplicated data is not being saved onto the system. Instead there is a message to inform the user that the data he or she entered is duplicated record. Thus, it minimizes the waste of memory space of the database.

➢ **Efficiency**

The system is able to process the information and provide the results within a very short period. All the functions that are in systematic ways, whereby the user can get theirs respected output or result immediately and accurately.

➢ **Simplicity**

Reducing application development complexity has provided a clear operating system upgrade path, and offers true portability. In addition, consider solutions that

are processor-independent, with clear platform momentum and a strong suite of developer resources.

3.4 Selection of Software

3.4.1 Platform

3.4.1.1 Microsoft Windows 2000 Server

The Windows 2000 is the evolutionary and built on NT technology. It is design especially for small business and professional users as well as to the more technical and larger business market for which the NT was designed. It was reported in earlier reviews that Windows 2000 is more stable than Windows 98/NT systems. It is likely to clash. The main reason for choosing Windows is that Windows currently enjoys a dominant position as the preferred operating system by most corporations. Microsoft's Windows enjoys a penetration rate of almost ninety percent of the overall market, which makes it almost the *de facto* choice for operating system.

Windows comprise of a user friendly Graphics User Interface (GUI) which makes it easy for both consumers and computer professionals to use. Although Linux also provides a user friendly GUI, it undoubtedly has a much lower usage percentage in corporations. This prompted me to choose the more popular and latest Windows 2000 over Linux. UNIX on the other hand does not provide its users with user friendly GUI.

3.4.2 Web Server: Internet Information Server

The Windows 2000 Server operating system integrates Internet technologies across all services, from File and Print to advanced line-of-business application services. This helps ensure organizations can more effectively exchange information with customers, partners, and employees worldwide.

Windows 2000 Server meets the needs of a broad spectrum of users, from corporate intranets to Internet Service Providers hosting Web sites receiving millions of hits per day. Because Internet Information Server 5.0 (IIS) is fully integrated at the operating system level, Windows 2000 Server lets organizations add Internet capabilities that weave directly into the rest of their computing infrastructure.

Specifically, Windows 2000 Server lets organizations:

- **Share information more efficiently using the Web.** In the past, performing standard file operations on a network file share was much easier than performing similar operations on a remote Web site. Now, Windows 2000 Server technologies such as Web Distributed Authoring and Versioning (WebDAV) make it as easy to carry out standard file operations on a Web share.

- **Create Web-based business applications.** Creating Web-based applications that integrate well into traditional business applications can be difficult. Windows 2000 Server overcomes this burden by sharing internet-aware application development tools with IIS, an efficiency that extends applications to the Web and eliminates awkward bridges between internal and external processes.

- **Bring server operating system functionality to the Web.** In addition to allowing organizations to extend basic file and print services to the Web, Windows 2000 Server supports applications, media, and communications

and networking services from a common server platform. This convergence means that everything a company can do with Windows 2000 Server is automatically supported in a fully integrated Web environment.

Analysis:

Microsoft Internet Information Server is selected as the web server. The following are the reasons:

1. It comes together with Windows 2000 Server as a free tool.
2. Internet service support is built into the operating system using IIS, therefore all aspects of Internet service can be managed from a single console, either locally or remotely which includes HTTP, FTP, SMTP, and NNTP services.
3. Microsoft products have been well known for its products support, so user can easily get any support for the Internet Information Server compared to Apache Web Server and Netscape Enterprise Server.
4. Administrator could easily manage and configure the web server services in Internet Information Server as Windows 2000 Server provides a standard graphical user interface. Most importantly, Internet Information Server is compatible and part of the software requirements for using Microsoft Commerce Server.

3.4.3 Database: Microsoft SQL Server 2000

Business today demands a different kind of database solution. Performance, scalability, and reliability are essential, and time to market is critical. Beyond these core enterprise qualities, SQL Server 2000 provides agility to data management and analysis, allowing organization to adapt quickly and gracefully to derive competitive advantage in a fast-changing environment. From a data management and analysis perspective, it is critical to turn raw data into business intelligence and take full advantage of the opportunities presented by the Web. A complete database and data analysis package, SQL Server 2000 opens the door to the rapid development of a new generation of enterprise-class business applications that can give company a critical competitive advantage. The record-holder of important benchmark awards for scalability and speed, SQL Server 2000 is a fully Web-enabled database product, providing core support for Extensible Markup Language (XML) and the ability to query across the Internet and beyond the firewall.

3.4.4 WAP Application Language – Wireless Markup Language

WML stands for Wireless Markup Language, and is the language utilized by wireless devices. It is based on XML, but in reality WML is an XML application. If you're going from HTML chances are you'll find WML somewhat restrictive in comparison to HTML. WML is read and interpreted by a browser built into the WAP device in much the same was as a desktop browser renders standard HTML pages. The browser or user agent is commonly called a micro browser. The capabilities of the micro browser are severely limited due to the relatively small screen size and processing power of WAP devices. All WML is compressed and/or tokenized before it is sent to a WAP device. Some of the current

3.4.5 Scripting Language – WMLScript

WMLScript is based on ECMAScript, the same scripting language that JavaScript is based on. It can be used for enhancing services written in WML in the way that it to some extent adds intelligence to the services, for example procedural logic, loops, conditional expressions, and computational functions.

WMLScript can be used for e.g. validation of user input. Since WML does not provide any mechanisms for achieving this, a round-trip to the server would be needed in order to determine if user input is valid or not if scripting was not available. Access to local functions in a wireless device is another area where WMLScript is used; for example access to telephony related functions. WMLScript does also support WMLScript Libraries. These libraries contain functions that extend the basic WMLScript functionality. This provides a means for future expansion of functions without having to change the core of WMLScript. Just as with WML, WMLScript can be binary encoded by the WAP Gateway/Proxy in order to minimise the amount of data sent over the air.

3.4.6 Programming Language – Microsoft Visual Basic 6.0

Visual Basic 6.0 is one of the products in Microsoft Visual Studio Package. It allows users to develop Windows application quickly and easily without being expert in other programming languages. Visual Basic provides a graphical environment in which user can visually design the forms and controls that building blocks of applications.

Visual Basic supports many tools, especially to build 3-D Windows "look and feel" interface that will help users be more productive. The tools are not limited to, projects, forms, class objects, templates, custom controls, add-ins, and database managers, users also can use the tools together to create complete applications in months, weeks, or even days; producing an application using another language can take much longer.

Some of the Visual Basic 6.0's features and advantages are as followed:

- Easy to use and has fast development period.
- Visual Basic 6.0 provides more of the actual code for a programmer than any other non-visual programming language.
- The built-in interface creation capability furthers the standardization on the user interface to Windows applications.
- Saving the users' time by eliminating time spent for writing code to create the user interface to his applications (the visual interface).
- Tools that perform a full range of development tasks.
- Templates (code, property, control) that allow users to reuse code, control property sets, and entire controls with their associated code.
- An enhanced design time environment. The IDE Function Library gives the users instant working code. And the formatter object and expanded Object browser provides users access and work with code in new, innovative, and faster ways.
- A macro facility that lets users to create their own tools without the overhead of the VB6 Add-in Model.

3.4.7 Programming Language – Microsoft eMBedded Visual Basic 3.0

Microsoft® eMbedded Visual Basic® 3.0 enables you to develop Windows CE-based applications using an integrated development environment (IDE) similar to that used in developing desktop Visual Basic applications. This IDE, however, contains Windows CE-specific versions of many of the standard development tools you use to create, test, and refine your applications. It also includes a variety of tools that help you develop new software uniquely appropriate for Windows CE platforms and devices.

Applications can be created with eMbedded Visual Basic to run on Handheld PC Pro (H/PC Pro), Palm-size PC 1.2, and Pocket PC platforms. You can also use eMbedded Visual Basic to create applications which run on custom Windows CE-based platforms, or within a desktop emulator that simulates a Windows-CE based platform.

3.4.8 Web Application Technology – Active Server Pages 3.0 (ASP)

ASP was "born" in November 1996 when Microsoft announced its design of an Active Platform. The Active Platform reflects Microsoft's ideas about how a desktop computer and a server computer should communicate. It consists of two parts: the Active Desktop and the Active Server. The Active Desktop refers to the client side, or the user's side, where HTML files are displayed on a web browser. The Active Server refers to the server-side component. This consists of pages that can be interpreted by the server, hence the term Active Server Pages.

Microsoft's documentation describes ASP as "a server-side scripting environment that you can use to create and run dynamic, interactive, high-performance Web server applications." ASP files combine HTML, scripts, and ASP code to enable a much higher degree of interactivity than is possible with plain vanilla HTML. With ASP, programmers working on Windows NT can tailor the way pages are displayed based on outside information. A different image could be displayed each day of the week, or information could be displayed based on a user's age. This process, which is called condition branching, allows ASP to make decisions about what to display based on certain criteria.

HTML, on the other hand, has no way to make this type of decision. It's a display language. In the real world, you'll probably want to interact with users through a web storefront or personalize their experience by offering tailored content. For this, you need the ability to make decisions.

Active Server Pages is a programming environment that gives the ability to generate dynamic html pages with the help of server side scripting. With ASP, you can combine HTML pages, script commands, and ActiveX components to create interactive Web pages or powerful Web-based applications.

VBScript is the default scripting language for ASP, but if you like you can use VBScript, JScript, Perl or any other scripting language for server side scripting in an ASP page. An ASP page is almost the same as a HTM or HTML page... the only difference is that an ASP page has the '.asp' extension. Active Server Page can include

both client side and server side scripts. In an ASP page VBScript is usually used as the server side and Java Script as the client side scripting language.

In short, ASP is an open Web application framework that lets developers combine server scripting with custom components to provide dynamic Web-enabled applications – much like a "super glue" for dynamic Web-enabled application development.

3.5 System Requirements

3.5.1 Client/Server Technology

Client and server are software and not hardware entities. In its most fundamental form, client/server involves a software entity (client) making a specific request which is fulfilled by another software entity (server). The client process sends a request to the server. The server interprets the message and then attempts to fulfill the request. In order to fulfill the request, the server may have to refer to a knowledge source (database), process data (perform calculations), control a peripheral, or make an additional request of another server. In much architecture, a client can make requests of multiple servers and a server can service multiple clients.

When considering a move to client/server computing, whether it is to replace existing systems or introduce entirely new systems, practitioners must determine which type of architecture they intend to use. The vast majority of end user applications consist of three components: presentation, processing, and data. The client/server architectures can be defined by how these components are split up among software entities and distributed on a network. There are a variety of ways for dividing these resources and implementing client/server architectures.

Most application programs have three major layers. On top is the *presentation layer*, which provides the human/machine interaction (the user interface). The presentation layer handles input from the keyboard, mouse, or other device and output in the form of screen displays. In the middle is the *application* or *business logic*, the functionality that gives the application program its character. Application logic makes the difference between an order entry system and an inventory control system, for example; it is often called *business logic* because it contains the business rules that drive a given enterprise. The bottom layer provides the generalized services needed by the other layers, including such

things as file services, print services, communications services, and, perhaps most important, database services.

The number of *tiers* in a client/server application is determined by how tightly or loosely the three program layers are integrated. In this project, the system requires a three-tier application.

Three-tier client/server applications break all three program layers into independent sections. We have already seen how the database service can run on a different computer. In three-tier designs, the business logic itself becomes a service, and that service can be run on its own computer. When the business logic becomes a service, it is usually called an application server or simply app server.

Quite often, the app server runs on the same physical server hardware as the database. Collocation can sometimes benefit performance, so it is usually a first choice. Nevertheless, a key advantage of having an app server is that it can be located in the best place to serve the need.

If you run a business with sales regions, for example, some regions might have many salespeople sharing an app server that is running on a separate physical computer. However, the one salesperson in a remote region might run both the client and the app server on a single PC. No matter how the client and app server are configured, all app servers might receive database services from a centralized computer, perhaps a mainframe. Moreover, no matter how the app server is deployed, all users operate the application in exactly the same way from the client. The locations of the app server and the database server are irrelevant to the user.

In a three-tier client/server application, the presentation layer usually does not have intimate knowledge of the database. Instead, the presentation layer communicates with its application server using a predefined message strategy.

Three-tier applications are much more difficult to build than two-tier apps. The biggest obstacle is that the software tools' integrated development environments are

not aware of the three-tier model the way they are about the two-tier model. As a result, much more hand coding is required to write a three-tier application. Three-tier apps are also harder to design, because they are somewhat abstract compared with their more direct two-tier counterparts. Software tool vendors are starting to release new versions that tout three-tier or n-tier development support, but it is not mature development technology just yet.

One point of interest is that a two-tier relationship exists between an app server and its database server. In other words, even though the client in a three-tier application does not have intimate database knowledge, the app server does.

The term "n-tier" is quite in vogue right now. In truth, three tiers are the maximum; "n-tier" refers to the fact that an application server can request services from many other services, and that the services themselves can ask for services as needed to respond properly to the client's original request. The message flows can get pretty complex.

When designing and building a three-tier client/server application, most developers make conscious decisions about how much of the business logic to move into the independent app server. A good example of this is input-data validation. Most users like immediate feedback when a datum is invalid. If the app server lives on a different physical computer, there can be a delay before the presentation layer in the client reports that an entry is invalid. To keep good performance, validation rules often live with the presentation layer in the client.

Client/server is an open system. It offers organizations the ability to distribute processing and data across networks using powerful graphical workstations, servers, and mainframes. The client/server model enables rightsizing, the selection and location of computing resources according to the needs of individuals and work groups. One of the prime benefits of a client/server system is lower costs. Another is increased productivity from the individual to the corporation that results from better access to information and the distribution of resources through the corporation. Additional benefits of client/server include:

- Interoperability - key components (client/server/network) work together.
- Scalability - any of the key elements may be replaced when the need to either grow or reduce processing for that element dictates, without major impact on the other elements.
- Adaptability - new technology may be incorporated into the system.
- Affordability - cost effectiveness is insured by using less expensive MIPs available on each platform.
- Data Integrity - entity, domain and referential integrity are maintained on the database server.
- Accessibility - data may be accessed from WANs and multiple client applications.
- Performance - performance may be optimized by hardware and process.
- Security - data security is centralized on the server.

3.6 System Architecture

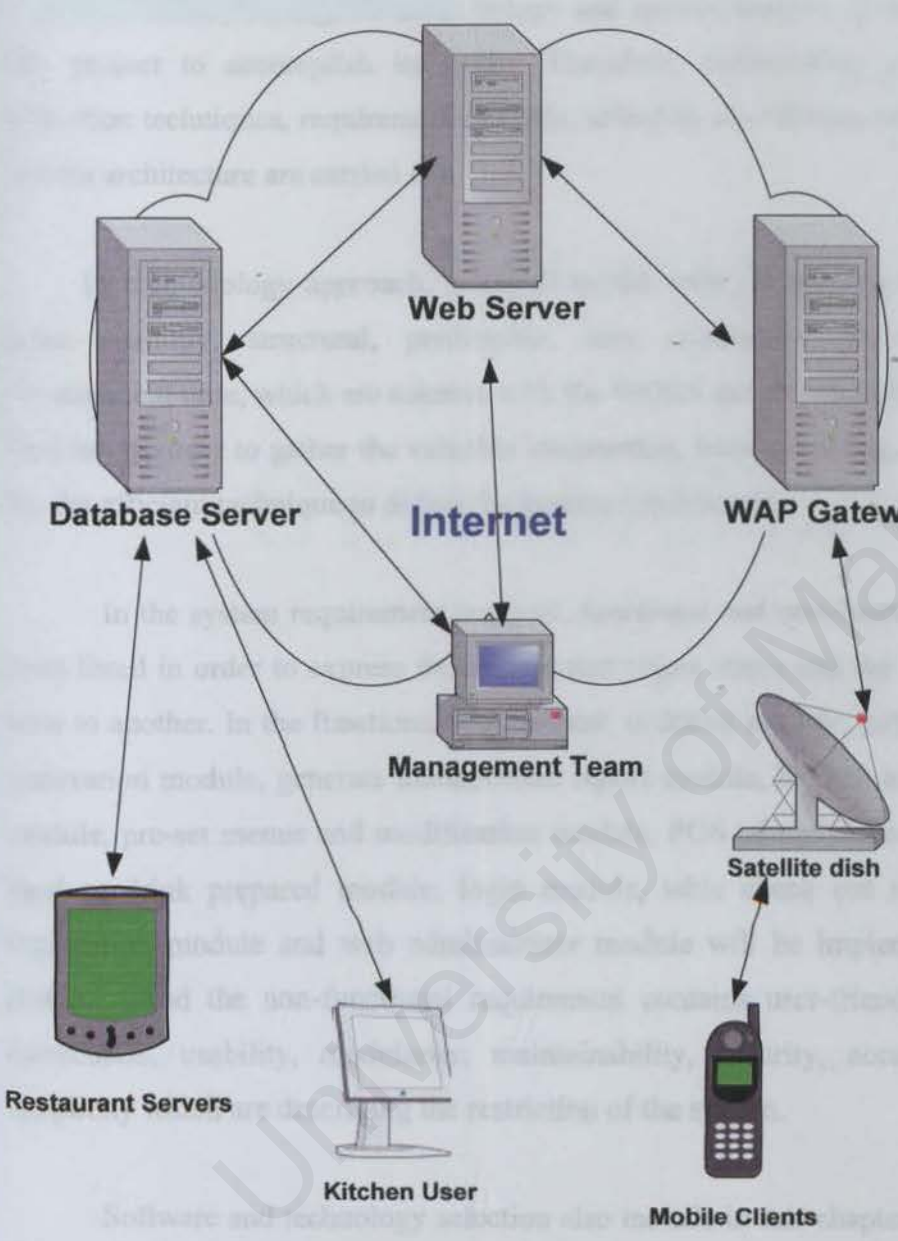

Figure 3.2 System Architecture for Restaurant System

3.7 Summary of Chapter 3

In this chapter, a good methodology and system analysis is very important to allow this project to accomplish its goal. Therefore, methodology approach, information collection techniques, requirement analysis, selection of software, system requirement and system architecture are carried out.

In methodology approach, waterfall model with prototyping has some advantages, good visibility, structural, predictable, user orientation, more efficient and fast development time, which are suitable with the WORS development life cycle. Besides, in order to gather the valuable information, internet surfing, observing and library are the efficient technique to define the system requirement.

In the system requirement analysis, functional and non-functional requirement has been listed in order to express the system and object states and the transactions from one state to another. In the functional requirement, ordering module, payment module, mobile reservation module, generate management report module, kitchen and bar display system module, pre-set menus and modification module, POS administrator module, notification food or drink prepared module, login module, table check out module, new member registration module and web administrator module will be implemented in the WORS system. And the non-functional requirement contains user-friendly, speed, reliability, correctness, usability, modularity, maintainability, security, accuracy, efficiency and simplicity which are describing the restriction of the system.

Software and technology selection also include in this chapter. They are Microsoft Windows 2000 server, Microsoft Internet Information Service 5.0, Microsoft SQL server 2000, Wireless Markup Language (WML), WML script, Active Server Pages, Microsoft Visual Basic 6.0 and Microsoft eMbedded Visual Basic 3.0. and the system requirement of this WORS is the client-server technology with three-tier technology.

CHAPTER 4

SYSTEM DESIGN

Chapter 4: System Design

4.1 Introduction

The system design phase is the phase in which requirement produced in the system analysis phase are translated into a representation of the system. This phase will be concerned with functional design, user interface design and database design. The functional and database design will be continue in the next semester.

4.2 Data Flow Diagram

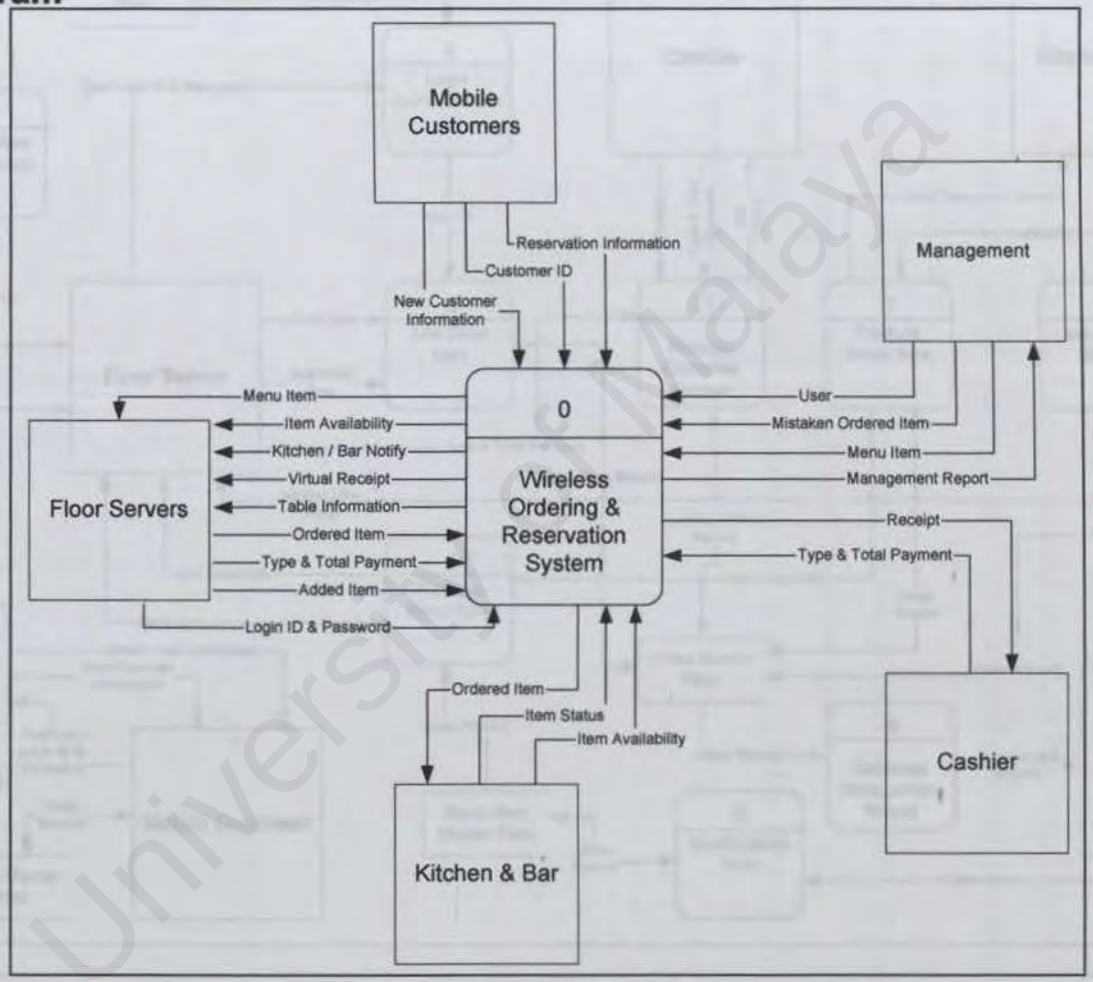

Figure 4.1 Context Diagram for WORS

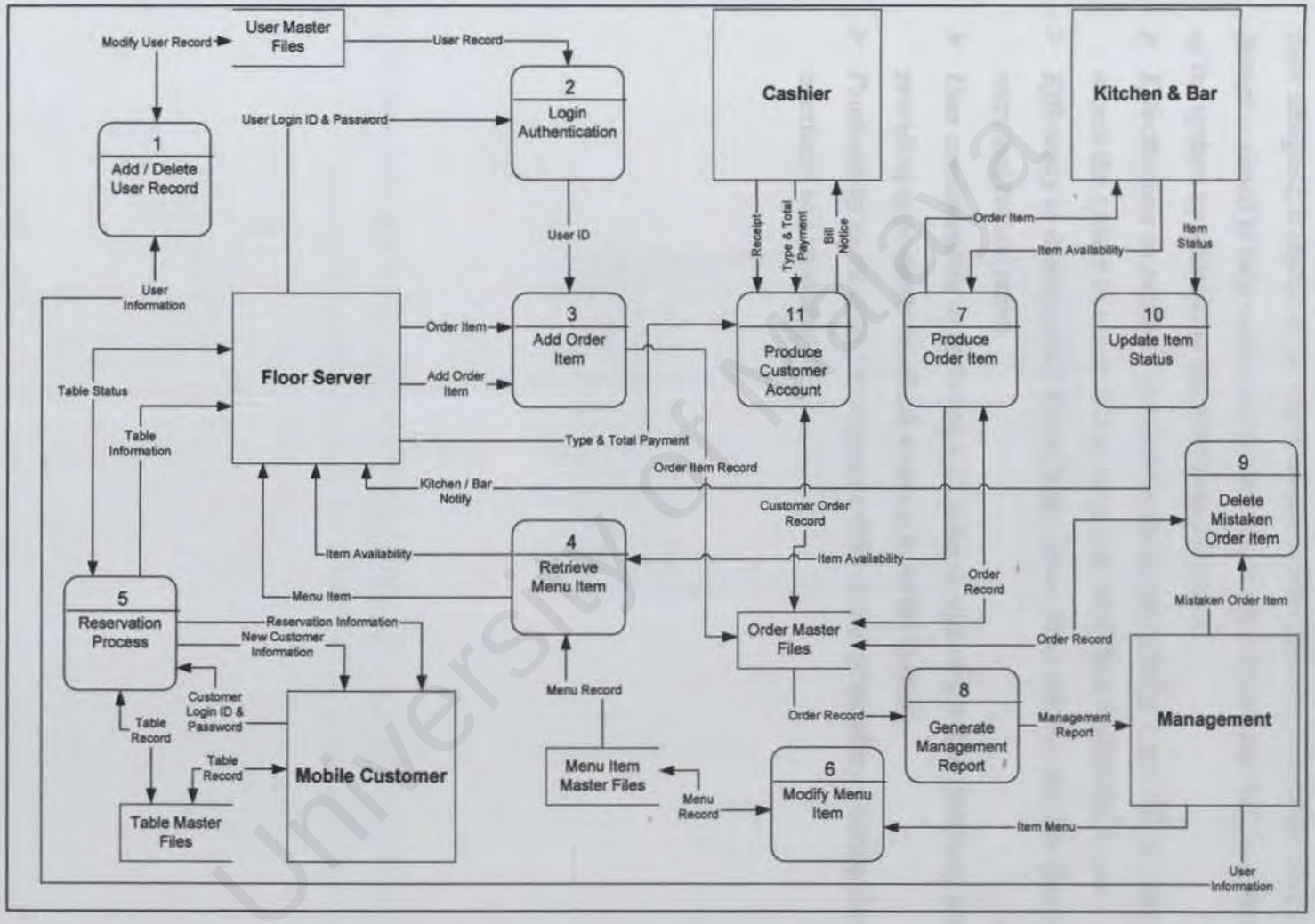

Figure 4.2 Diagrams 0 for WORS

4.3 Interface Design

User interface design is very important to the usability of an application. Well or poor designed; it stands as the representation of the system. Therefore, user interface design is aimed to help users and businesses get the information they need in and out of the system by addressing the following objective:

- ***Effectiveness*** as achieved through the design of interfaces that allow users to access the system in a way that is congruent with their individual needs.
- ***Efficiency*** as demonstrated through interfaces that both increase the speed of data entry and reduce errors.
- ***User consideration*** as demonstrated in the design of suitable interfaces and by providing appropriate feedback to users from the system.
- ***Productivity*** as measured by ergonomically sound principles of design for user interfaces and workspaces.

4.3.1 Interface Design for Wireless Ordering & Reservation System

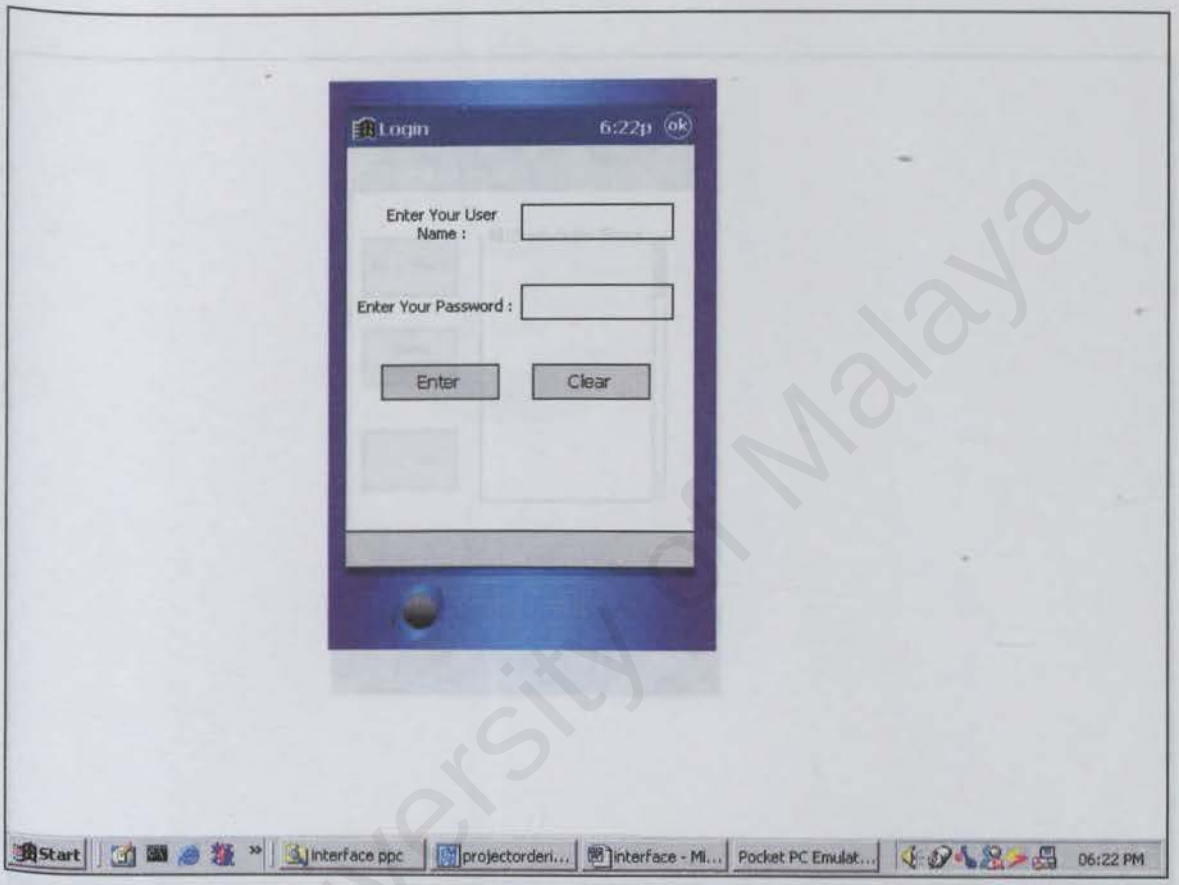

Figure 4.3 Interface design for WORS's Login Screen

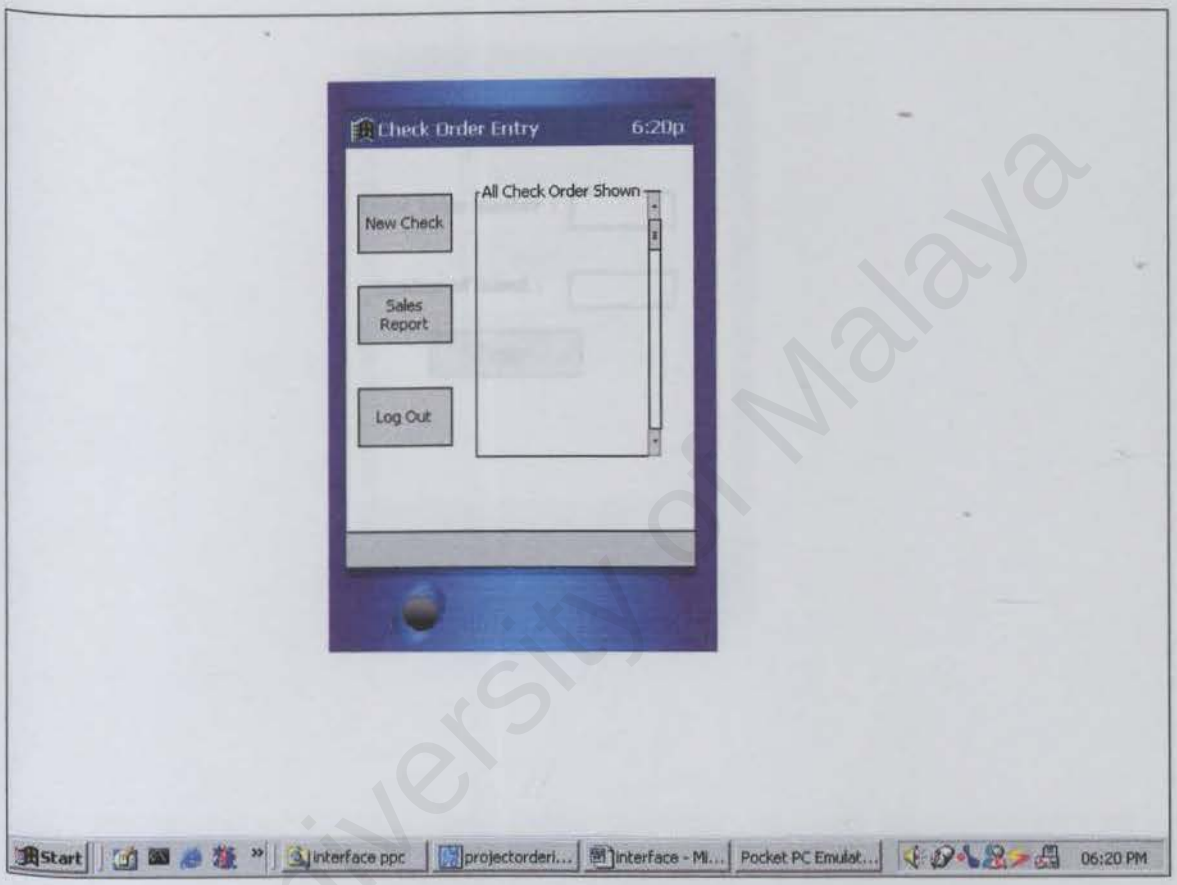

Figure 4.4 Interface design for WORS's Check Order Entry screen

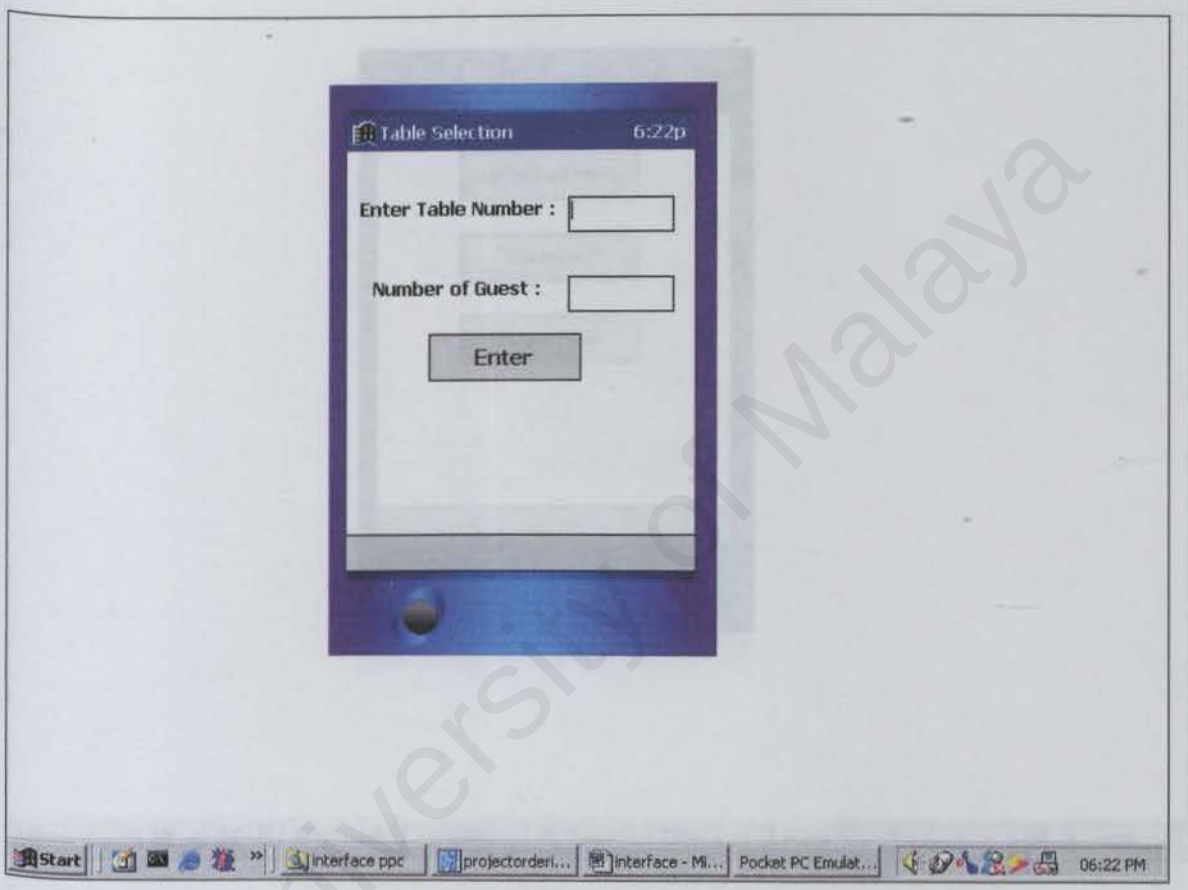

Figure 4.5 Interface design for WORS's Table Selection screen

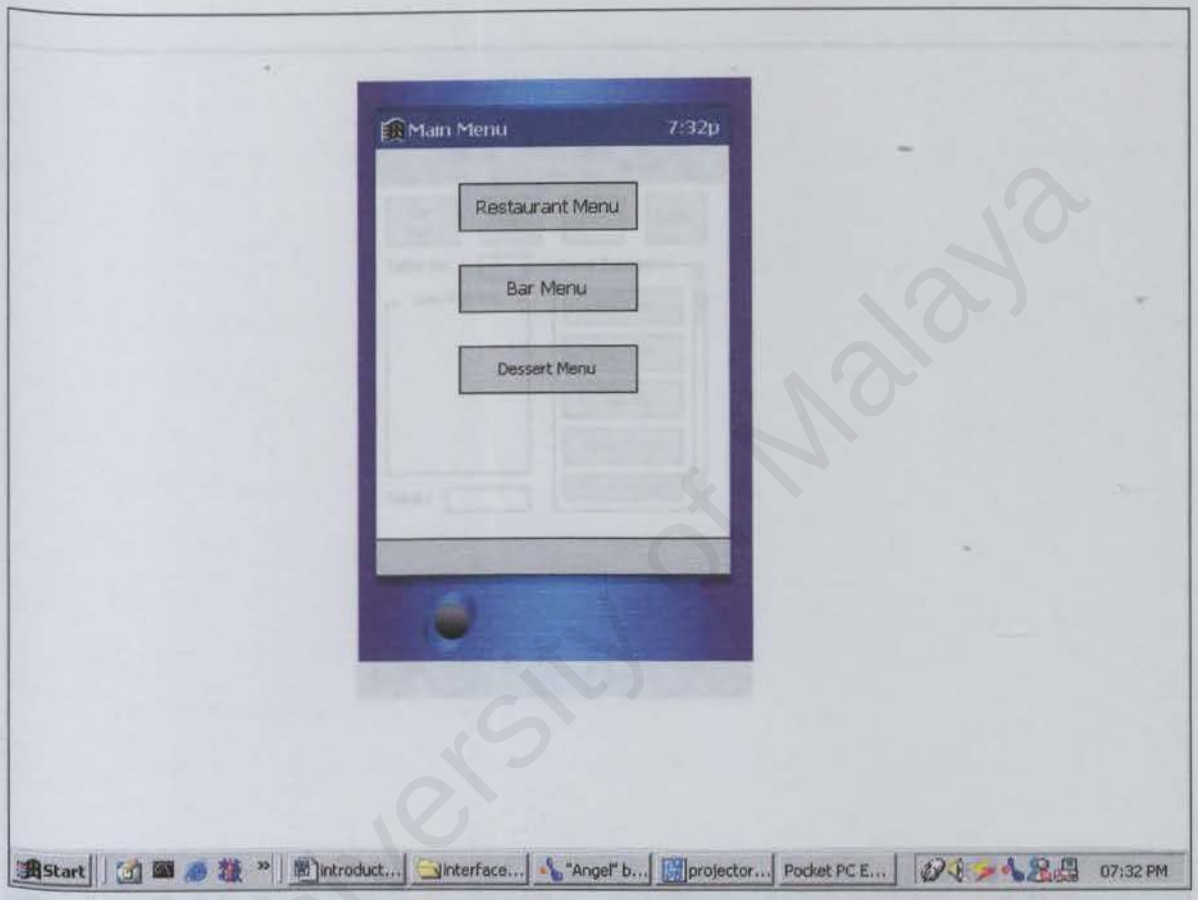

Figure 4.6 Interface design for WORS's Main Menu screen

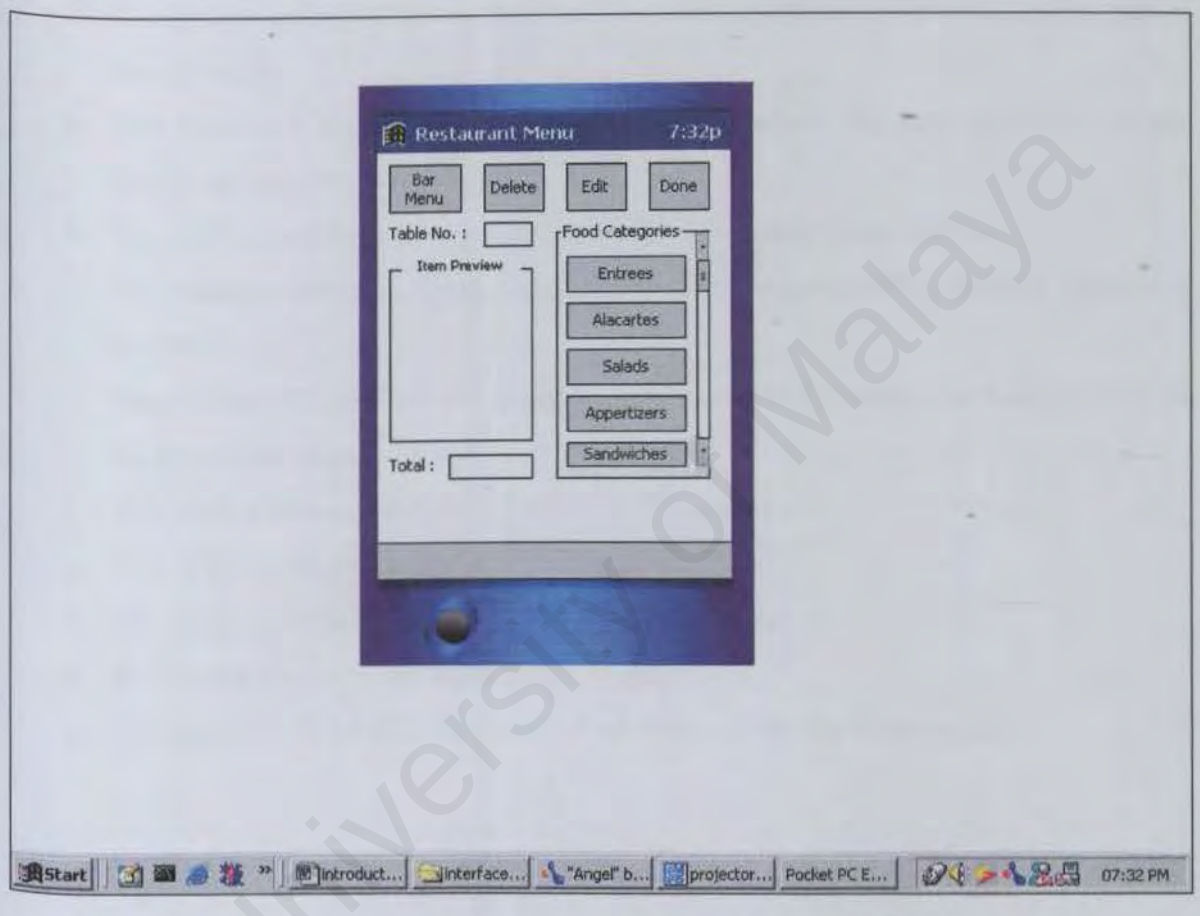

Figure 4.7 Interface design for WORS's Restaurant Menu screen

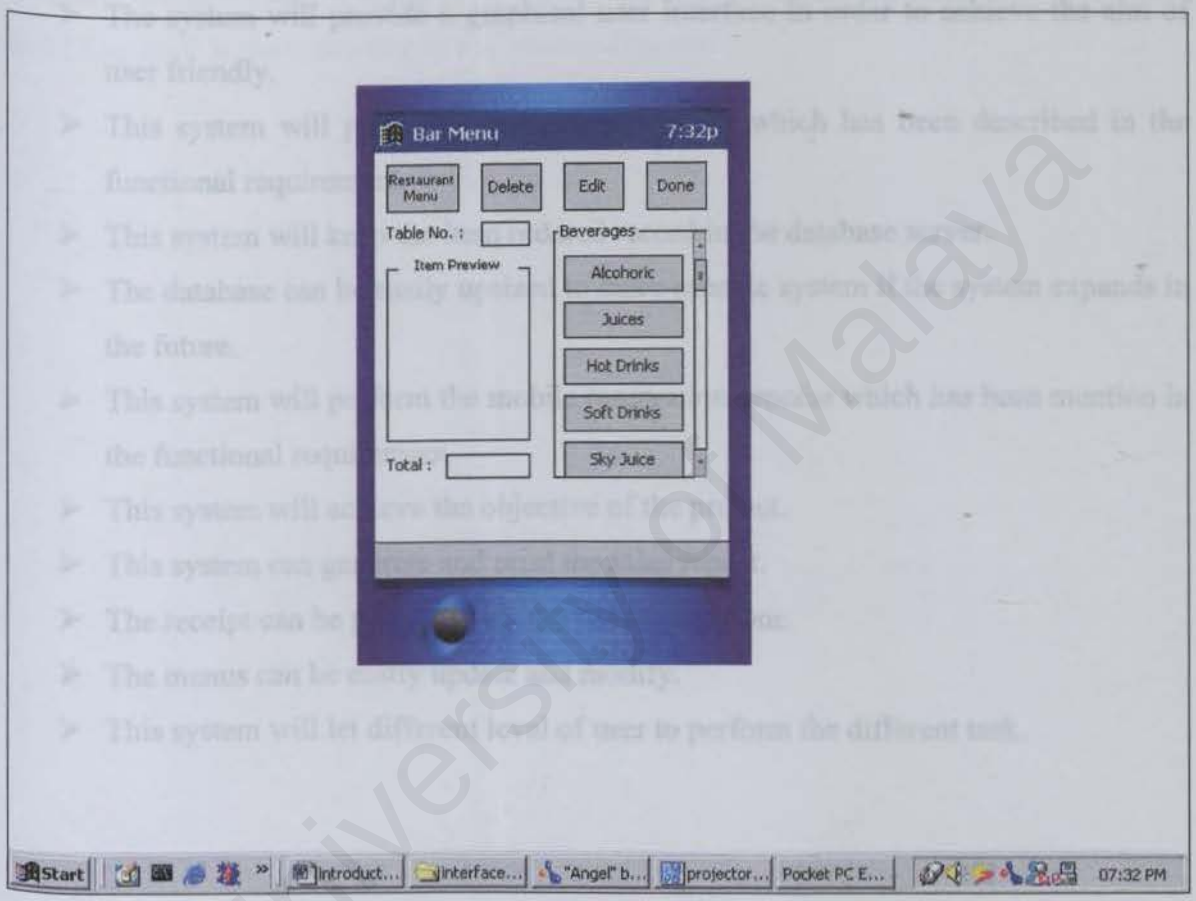

Figure 4.8 Interface design for WORS's Bar Menu screen

4.4 Expected Outcome

This system will simulate the ordering process by using the pocket pc emulator and the reservation process by WAP emulator. Therefore, the expected outcomes of this project are shown as below:

- The system will provide a graphical user interface in order to achieve the aim of user friendly.
- This system will perform the ordering process which has been described in the functional requirement.
- This system will keep the item ordered record in the database server.
- The database can be easily upsized to more capable system if the system expands in the future.
- This system will perform the mobile reservation process which has been mention in the functional requirement.
- This system will achieve the objective of the project.
- This system can generate and print the sales report.
- The receipt can be printed when the payment is done.
- The menus can be easily update and modify.
- This system will let different level of user to perform the different task.

4.5 Summary of Chapter 4

In this chapter, data flow diagram, WORS interface and the expected outcome are included. It provides an overview of the WORS system which will be develop in WXET 3812.

Context Diagram and Diagram 0 are the diagrams which included in the Data Flow Diagram design. Context Diagram is the first diagram to grasp the basic data movement and Diagram 0 is the exploding to the context diagram.

CHAPTER 5

SYSTEM IMPLEMENTATION

Chapter 5: System Implementation

5.1. Introduction

The requirement analysis, methodology and system design phases do not have a clear boundary in a software project. Each phase tends to overlap one another. System implementation is a process that converts the system requirements and design into program codes.

5.2 System Development

System development consists the used of methodology chosen, forms coding, development tools, database connection and configuration on server. The details are illustrated as below:

5.2.1 Methodology

This project is developed using the waterfall approach. The development of this project will consist of five stages, which are requirement, design, coding, testing and operation. The system is design using logical flow and it allows the estimation of the milestones. Each stage must be completed before proceed to the next stage to ensure that the system is built according to the requirements and specifications.

5.2.2 System Coding

Coding is an iterative process whereby it is done until the programmer obtains the desired results. There are two types of coding approach; one is top-down and the other one is bottom-up. The bottom-up coding is based on coding some complete lower level modules and leaving the high level modules merely as skeletons that are used to call the lower modules, whereas the top-down approach is the reverse.

For this system, coding is done with the bottom-up approach. The advantages of this approach are: testing can be carried out on some of the functions as soon as it is completed, and critical functions can be coded first to test their efficiency.

5.2.3 System Coding Tools – Visual Basic

Visual Basic is used to develop this system because it provides a set of tools that make it easy to develop powerful Windows applications [4]. The "Visual" part refers to the method used to create the graphical user interface (GUI). Rather than writing numerous lines of code to describe the appearance and location of interface elements, just simply add pre-built objects into place on the screen. The "Basic" part refers to the BASIC (Beginners All-Purpose Symbolic Instruction Code) language, a language used by more programmers than any other languages in the history of computing. Visual Basic has evolved from the original BASIC language and now contains several hundred statements, functions, and keywords, many of which relate directly to the Windows GUI. Beginners can create useful applications by learning just a few of the keywords, yet the power of the language allows professionals to accomplish anything that can be accomplished using any other Windows programming language [1].

Visual Basic also provides data access features to create databases, front-end applications, and scalable server-side components for most popular database formats, including Microsoft SQL Server and other enterprise-level databases [1].

5.2.4 Database Connection

The database for this project is created using Microsoft SQL Server 2000and Microsoft SQL Server 2000 for CE. The processes of creating database, creating and modifying tables and their relationship is made easy.

Active X Data Object (ADO) is used to store and retrieve data from the database. This project uses the (Data Source Name) DSN-less connection strings to connect to Microsoft SQL Server. The connection string is written as follows:

```
Provider=SQLOLEDB;Password=wors;Persist Security Info=True;User
ID=wors;Initial Catalog=WROS;Data Source=P41500
```

All communication with a database takes place through an open connection. Before any information can be inserted into or retrieved form the database, a connection with the database must e established. The ADO connection object serves the purpose. For example:

```
Set objConn = server.CreateObject ("ADODB.Connection")
objConn.Open strConnect
```

The database for Pocket Pc is created using Microsoft SQL Server 2000 for Windows CE. The database in Pocket Pc is away retrieve form the SQL server 2000. To transfer or synchronize data between Microsoft SQL Server CE and SQL server 2000, a method is called Remote Data Access (RDA), which is used to **pull** the data form SQL server 2000 and save into SQL server CE and then used **push** method to synchronized the database in Windows CE and SQL server 2000. Besides, Applications call the **SubmitSQL** method to submit SQL statements for execution on a remote SQL Server database. The codes are shown as below:

```
Const localProvider = "Provider=Microsoft.SQLSERVER.OLEDB.CE.1.0;Data Source="
Const localFileSpec = "EWORS"
Public Sub ceRDA_Prop()
  Set RDA = CreateObject("SSCE.RemoteDataAccess.1.0")
  RDA.InternetLogin = ""
  RDA.InternetPassword = ""
  RDA.InternetURL = "http://P41500/wors/sscesa10.dll"
  RDA.LocalConnectionString = localProvider & localFileSpec
  strRemoteConn = remoteProvider & remoteServerName & remoteDataBaseName
                & remoteUserId & remotePasswd
End Sub

Public Sub ceRDA(selection As Integer)
  Select Case selection
    Case 1
      Call ceRDA_Prop
       RDA.Pull localRecipeTable, SelectServerRecipeTable, strRemoteConn,
           TRACKINGOFF
    Case 2
      RDA.Push localRecipeTable, strRemoteConn
    Case 3
      RDA.SubmitSQL SQLSubmit, strRemoteConn
  End Select

End Sub
```

Active X Data Object (ADO) for Windows CE is used to store and retrieve data from the database for palm handheld device. This project uses the Remote Data Access (RDA) to connect to Microsoft SQL Server CE with Microsoft SQL Server 2000. The connection string is written as follows:

```
Provider=Microsoft.SQLSERVER.OLEDB.CE.1.0;Data Source=EWORS
```

All communication with a database takes place through an open connection. Before any information can be inserted into or retrieved form the database, a connection with the database must e established. The ADO connection object serves the purpose. For example:

```
Public Function openConnection() As Boolean
On Error Resume Next
  openConnection = True
  If Conn Is Nothing Then
    Set Conn = CreateObject("ADOCE.Connection.3.1")
    Conn.Open localProvider & localFileSpec
    If Conn.Errors.count > 0 Then
      closeConnection
      openConnection = False
    End If
  End If
  On Error GoTo 0
End Function
```

The example to close the connection is shown as below:

```
Public Sub closeConnection()
On Error Resume Next
  If Not Conn Is Nothing Then
    Conn.Close
    Set Conn = Nothing
    If Err.Number > 0 Then
      'MsgBox Err.Number & Err.Description & "CloseConnection"
    End If
  End If
  On Error GoTo 0
End Sub
```

5.2.5 Server Configuration

In the IIS Configuration, the first step is to create a virtual directory which will user for the SQL Server CE agent. For example:

E:\inetpub\wwwroot\wros

The following step is to grab the sscesa10.dll file and copy it to the virtual directory which has been created. After that, register the DLL. For example:

Regsvr32 e:\inetpub\wwwroot\wros\sscesa10.dll

After the configuration is complete, the SQL Server CE is able to connect to the SQL server by using this http connection. For example:

http://P41500/wros/sscesa10.dll

CHAPTER 6

SYSTEM TESTING

Chapter 6: System Testing

6.1. Introduction

Testing is a critical step in assuring the quality of the developed system and is representing the ultimate review of specification, design and coding. Testing is performed to ensure that the programs are executed correctly and conforms to the requirements specified. It provides a method to correct logic error and for testing system reliability.

6.2 Testing techniques

There are two type of testing technique applied in the testing stage of the system: white box testing and black box testing.

6.2.1 White box testing

White box testing is a testing case design method that uses the control structure of the procedural design to derive test cases. Using white box testing, test cases with the following characteristics can be derived:

? Guarantee that all independent paths within a module have been exercised at least once.

? Exercise all logical decision on their true or false sides

? Exercise on al loops at their boundaries and within their operational bounds

? Exercise on internal data structures to ensure their validity

6.2.2 Black box testing

Black box testing focuses on the functionality requirements of the system. It enables the developer to derive sets of inputs conditions that will fully exercise all functional requirements fro an application. Black box testing was not used as an alternative to white box testing technique rather this technique is used as a complementary approach

that is likely to uncover a different class of errors. Black box testing attempts to find errors in the following categories.

? Incorrect or missing functions
? Interface errors
? Errors in data structures or external data access
? Performance error
? Initialization and termination errors

6.3 Testing strategies

There are three types of testing, namely, unit testing, module testing and integration testing. After a program is completely coded, it will be tested under unit testing. Module testing will start when all the programs under a particular module have been completely coded and tested under unit testing. The integration testing is to recover errors associated with interfacing when integrating all the modules.

The objective of testing is to find error and fault. Fault identification is the process of determining what fault or faults caused the failure, and fault correction or removal is the process of making changes to the system so that the faults are removed.

There are several types of faults where it can be categorized as algorithmic faults, syntax faults and documentation faults. Algorithmic fault occurs when a program algorithm or logic does not produce the proper output for a given input because something is wrong with the processing steps. Syntax fault can be checked while parsing for algorithmic faults. This will ensure that the construct of programming language is used properly. Documentation fault occurs if the documentation does not match what the application does, and such faults can lead to other faults later because of the wrong implementation.

6.3.1 Units testing

Units testing focus on verification effort on the smallest component of the system design. Each component is treated as a standalone entity and tested individually to ensure that they operate correctly. The unit test is usually white-box oriented and the step can be conducted in parallel for multiple components.

The test that occurs as part of unit tests is illustrated schematically in *Figure 6.1*. The module interface is tested to ensure that information properly flows into and out of the program unit under test. The local data structure is examined to ensure that data stored temporarily maintains its integrity during all steps in an algorithm's execution. Boundary conditions are tested to ensure that the module operate properly at boundaries established to limit or restrict processing. All independent paths (basis path) through the control structure are exercised to ensure that all statements in a module have been executed at least once. Finally, all error-handling paths are tested.

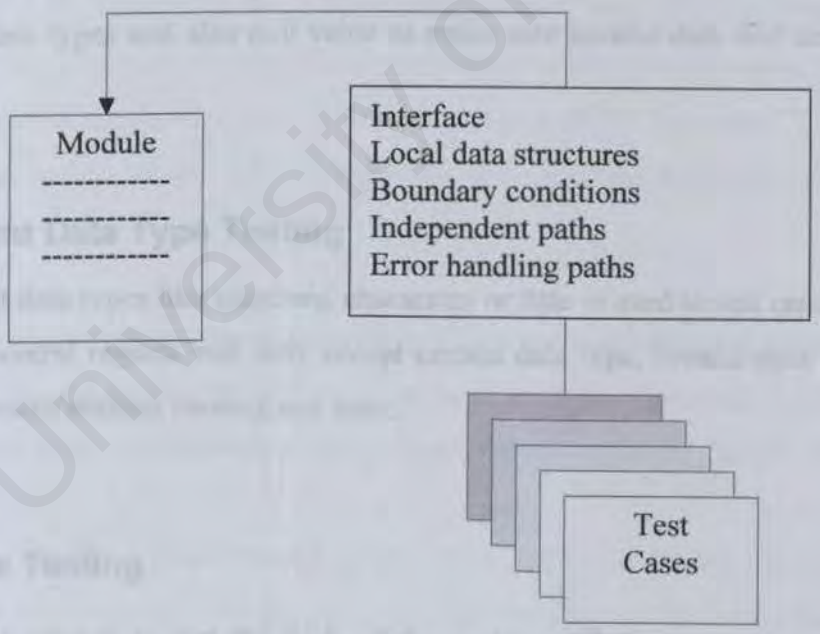

Figure 6.1 Unit Test

The following areas were tested during unit testing for this project:

? **Boundary value analysis**

Ensure that the module operates properly at boundaries established to limited or restrict processing.

? **Testing all error handling paths**

Ensure that the specific module executes the recovering process while an error occurs. For example, the updating process should be able to continue to function again after encountering duplicate record in the database.

? **All possible independent program paths are executed**

Ensure that the control structures are implemented correctly.

6.3.2 Control Objects Testing

Command buttons are clicked to test their functionality and text boxes are tested with different data types and also null value to make sure invalid data will not cause any fault.

6.3.3 Different Data Type Testing

Different data types like numbers, characters or date is used to test certain function because some control objects will only accept certain data type, invalid data type can be traced by the system without causing any error.

6.3.4 Module Testing

Module testing is to test the form of the system. All the programs under a sub-module are grouped into one form and all the related forms are grouped into a module. This testing will make sure all the forms are link to the right location.

6.3.5 Integration testing

Integration testing is a systematic technique for constructing the program structure while at the same time conducting tests to uncover errors associated with the interfacing. The objective is to take unit tested components and build a program structure that has been dictated by design. This testing will ensure that the section in this project, which are call module, to be arranged correctly.

The approach used in this phase is an incremental strategy, the bottom-up integration and regression testing. The incremental integration is the antithesis of the high bang approach. This web application is constructed and tested in small increments where errors are easier to isolate and correct. All the interfaces are tested completely and a systematic test approach is applied.

For this project, a bottom-up approach has been used. Bottom-up integration testing begins construction and testing with modules at the lowest levels of the system and then moving upward to the modules at the higher levels of the system. Regression testing is the re-execution of some subset of tests that already been conducted to ensure that changes have not propagated unintended side effects. It is the activity that helps to ensure that changes (due to testing or for other reason) do not introduce unintended behavior or additional errors.

At the culmination of integration testing, this project is completely assembled as a package, interfaces and linking errors have been uncovered and corrected. A final series of software tests that is the validation testing has been carried out during this phase.

Software validation is achieved through a series of black box tests that demonstrate conformity with requirements. For this project, a test plan has outlines the classes of tests to be conducted, and also a test procedure is used to defines specific test cases that will be used to in an attempt to uncover errors in conformity with requirements. Both the plan and procedure are designed to ensure that:

- All functional requirements are satisfied

- All behavior characteristic are achieved
- All performance requirements are attained
- Documentation is correct
- Other requirements are met (e.g. error recovery, maintainability, compatibility)

Alpha test and Beta test are also being carried out to uncover errors that only the end-user seems able to find. Alpha test is conducted at the developer's site by an end-user in a controlled environment. Beta test is conducted at one or more customer sites by the end-user of the software and it is a "live" application of the software.

6.3.6 Function Testing

Function testing is based on the system functional requirements. The testing is carried out for main modules. In the system, each function or sub has to test to the parameter passing to it and the return type true.

For example:

```
Public Function dbExecute(ByVal vSQLstmt As String,
                          returnType As EnumReturnType,
                          adoLockType As ADODB.LockTypeEnum,
                          adoCursorType As ADODB.CursorTypeEnum,
                          Optional begintransaction As Boolean = True
                          ) As Variant
On Error GoTo ErrorHandler
  Set Conn = New ADODB.Connection
  Set RS = New ADODB.Recordset
  If Conn.State = adStateClosed Then Conn.Open strconn
  Select Case returnType
    Case records
      With RS
        .LockType = adoLockType
        .CursorType = adoCursorType
        .Open vSQLstmt, strconn
```

```
        End With
        Set dbExecute = RS

    Case Value, None
        Dim AffectedRecord As Long
        If begintransaction Then Conn.BeginTrans
        Conn.Execute vSQLstmt, AffectedRecord
        dbExecute = AffectedRecord

  End Select
  Conn.Close
  Set RS = Nothing
  Set Conn = Nothing
  Exit Function

ErrorHandler:
  Dim i As Integer
  If (returnType = Value) Or returnType = None Then
    If begintransaction Then
      For i = translevel To 1 Step -1
        Conn.RollbackTrans
      Next
    End If
  End If
End Function
```

6.3.7 System testing

System testing is a series of different tests designed to fully exercise the software system to uncover its limitations and measure its capabilities. The objective is to test an integrated system and verify that it meets specified requirements. Although each test in this project has a different, all work to verify that system elements have been properly integrated and perform allocated functions.

There are several types of system testing that are worthwhile for a software system. For this project, three types of system testing are used:

? **Recovery Testing**

It is a system test that forces the systems to fail in variety of ways and verifies that recovery is properly performed. If recovery is automatic (performed by the system itself), then re-initialization, check-pointing mechanism, data recovery and restart are evaluated for correctness. If recovery requires human intervention, the mean-time-to-repair (MTTR) is evaluated to determine whether it is within acceptable limits.

? **Security Testing**

This system test will attempt to verify that protection mechanism built into the system will protect it from improper penetration.

? **Performance Testing**

The purpose of this testing is to test the run-time performance of software within the context of an integrated system. It requires both hardware and software instrumentation. Resource utilization is measured in an exacting fashion.

CHAPTER 7

SYSTEM EVALUATION

Chapter 7: System Evaluation

7.1. System Evaluations and Conclusion

During the period of coding and implementation of this system, various problems were encountered. These problems were solved through research and studies in fields such as the Internet, Online Books, journals and reference books. Besides that, a lot of system analysis has been done on technological and programming concepts to grasp the concept of Internet programming. The system's strengths, limitations and future enhancements were identified.

7.2 Problems Encountered and Solutions

There are several problems encountered throughout the development of Wireless reservation order system (WORS). These include:

7.2.1 Difficulty in Choosing a Suitable Development Technology, Programming Language and Tools

There are many software tools available to develop WORS system currently as stated in the earlier chapters. Choosing a suitable technology and tools was a critical process as all tools possesses their own strengths and weaknesses. In addition, the availability of the required tools for development was also a major consideration.

In order to solve the problem, seeking advises and views from project supervisor, course-mates and even seniors engaging in similar project were carried out. Furthermore, a lot of research and studies were done before any decision was made.

7.2.2 Lack of Knowledge in Visual Basic

Since there was no prior knowledge of programming in Visual Basic 6.0, there was an uncertainty on how to organize the codes. These new programming languages and concepts were never taught before and to implement such as application requires a fair

grasp of the languages. These programming approaches seem to be totally different from the traditional programming languages.

Although it really cause a lot of time to learn the new technology, but choosing to program in Visual Basic 6.0 proved to be a wise move. Most of the problems faced were manageable through browsing the Internet for related materials and referring to the reference books available in the market. Discussion with friends especially seniors using the same technology was a great help. A more efficient method was through trail and error during the coding phase.

7.2.3 Difficulty in Configuration of Microsoft Internet Information Server (IIS)

Another problem faced when developing this project is the difficulty in configuring the Microsoft Internet Information Serer. For example, in order to enable the secure communication using Secure Socket Layer (SSL), several steps must be carried out in sequence using the Key Manager. If one of the steps is not correctly done, then the whole operation will fail.

In order to solve the problems, research and studies on the Microsoft Internet Information Server are carried out. Besides that, solutions are also obtained from the documentation of the MS Internet Information Server, which was found in the Microsoft's official Website.

7.3 System Strengths

However, the implemented of this system can take advantages for the party involves in the restaurant. Thus, below are some of the strengths of this system.

? **Security**

This system is implemented with security login. For both administrator and user, login is required before using the system. The login screen requires user id and password only. If the user enters the wrong password, this system will not allow the

user to access the system until the correct password is entered. The administrator needs to set the new user to be active user before the user can login to the system.

For security purpose, only administrator login has the full access rights to the system and can make changes to the records in the database. There will be limited access rights for other user login.

? **Simple, user-friendly and easy to use interface**

WORS is developed using Graphical User Interface (GUI) based on development tools; therefore all forms are kept simple. This is to provide a user-friendly system to the user for fast learning and ease of use. Command button, text box and other control objects are used to allow the user to execute command with ease. An action is just a click away and the user just needs minimal knowledge of mouse and keyboard to use this system.

? **Display process message**

There are a lot of processes between the system and its database, therefore, it is important to inform the user what the system has done when clicking on any command button. Messages like 'Message sending Successfully' or 'Invalid user ID' will be displayed to inform the user. Without these messages, user might think that the system is faulty if no results are returned when a command is executed. In addition, user also knows that record is inserted into the database successfully.

? **Incorporates data validation**

Data validation is done prior to insert record into the database. All the fields in the form will be checked for null value or invalid data type. With this feature, error when inserting record into the database will not occur. Error message will also be prompted to the user if important field is not filled.

? **Fast response to information retrieval**

This system provides fast response to record searching and display in a report for the user such daily sales reports.

? **Implements error handling**

To avoid run time error, this system is developed with error handling. Error message will be displayed when the system encounters exceptions and it will not terminate suddenly.

? **Encryption of password**

All the passwords in the system are encrypted and stored in the database. The user will not figure out the password if the database is open by the user.

? **Improved customers system**

This system enables our labors to be more responsive and flexible to delivering fast and accurate services. This is because all waiter and waitress can access to the order that have done between them. Thus, this reduces the error rates in the ordering process and increase the amount of time spent by out waiter and waitress to serve customer.

? **Accuracy and efficiency**

With such kind of system, waiter and waitress will definitely using the palm handheld devices to taking down the order from customer. Thus, this situation causes the advantage to eliminate pen and paper and even the writing errors that going to face by labors. This is such as double handling of order information. Besides, eliminate the walking to and from the kitchen or bar with the order.

? **Fast and efficient ordering**

The touch screen palm provides waiter and waitress with a very simple and easy to use process to take, adjust and bill the order that requested by customer. Then, the order will directly transfer to kitchen, bar or cashier to enables the faster deliver of meal to customer.

7.4 System Constraints

Due to time and knowledge limitation, there are a few system constraints showed at below. This include

? **Database backup**

If this system is corrupted, there is no backup for the database and the user needs to reinstall the whole system. Therefore, all the reading material records will be lost and need to be entered again into the database.

? **Slow response time**

If there are a lot of records in the database, the searching process will take more time because the system will search the database and then generate the search results in a report for the user.

? **Can't record the specific order from customer needs**

This is due to the customer sometimes makes on order that want to add something in more specific. For instance, the order of meal wants to add little of chili or for drink such as coffee needs a little sugar. Thus, in this situation, such system is completely cannot to record such information.

? **Dependent on computer system and power**

This means that once the electricity is down, definitely the system cannot functional. Thus, this situation because the business operation of restaurant performed on that day would engage. This is due to the system cannot be used to taking down the order for customer. Besides, if the system is down cause by the failure of server or affected by virus, this situation will cause the system can't operate.

7.5 Problems and Solutions

During the development of this system, a number of problems delay the progress of this system. All the problems and solutions are explained below:

? **Problem on Database connection between Ms. SQL Server 2000 with Ms. SQL Server CE.**

When the database is opened by the system, the data transfer from palm will not allowed to access or update any record in the database from Ms. SQL Server 2000. Due to the fact above, an error will occur, and this will make the system faulty because it not allows palm handheld devices connect to Ms. SQL Server 2000.

Solution: Another database is needed to keep track on data sending by palm handheld devices. So, Ms. SQL Server CE is needed. In order to make a connection between Ms. SQL Server 2000 with MS. SQL Server CE, Remote Data Access (RDA) enables help to transfer synchronize data among them.

? **Date format**

The date format of system developed is DD/MM/YYYY, but retrieving record from the database with this date format will give wrong results although the record of date in the database is also in the same format.

Solution: The format of date in Access database follows US standard using MM/DD/YYYY. Although record is inserted using DD/MM/YYYY format, retrieving record will give wrong results if the format is DD/MM/YYYY. Therefore, date format should be MM/DD/YYYY to retrieve record from the database.

? **Error during packing the source code**

Error message is displayed and caused the packaging process to idle without any progress when the source code is compiled and packed to become setup file.

Solution: When packaging the source code, a setup list file will be generated. In the setup list file, there is one line missing a path. Therefore, open the setup list file with Notepad and add the path to the specific line, then save the file and pack the source code again.

? **Error during setup**

During installation of WORS, error message will be prompted out a few times.

Solution: This is the problem of Visual Basic packaging tool. The user just needs to click ignore and continue installation. This installation error will not cause any faulty to the system.

7.6 Future Enhancements

System development is a dynamic process and changes must be expected. Due to the limited resources that I have, especially time, this has caused me have missed or overlooked certain aspect of the system. However, after the development system has been completed, I have identified certain important aspects that I can add on or modify for future enhancement.

However, below are some of the additional features that can be implementing if time is given. The future enhancements features showed as below:

? **Database backup**

Once the system is corrupt, all the records in the database will lost and reinstall is needed to do again. This will take a lot of time to enter again all the reading material details into the database. Therefore a backup set of database is needed for restoring the old records.

? **Short message storing**

The system allows the administrator to type in short message and store in the database. This short message then can be send and view by the end user (waiter and waitress) with certain circumstance.

? Have a connectivity system that enables all restaurant (branches) share same information from their central site. (main restaurant)

? Have a good design interface for the waiter and waitress by modify certain part of the interface of the handheld computer that make it more easily to keep track

? Allow user to change their password through handheld devices.

7.7 Knowledge and Experience Gained

From the beginning of this project until the final documentation, a number of problems have occurred and experiences are learned from there. This project gives a lot of benefit and knowledge, there are:

? **The importance of all phases in SDLC**

System analysis is an important phase in the system development life cycle (SDLC). This phase is capturing user requirements and the goal of the system. If this phase is wrong defined, it will cause faulty to the system development and later progress. With a complete and thorough system analysis, the system that is developed will fulfill all the requirements and achieve its goal.

System testing is also an important phase in SDLC. There is no application that is free of error in this world. However, with the procedures in the system testing phase, errors and faults in the system can be minimized. The functionality of each module or form can also be tested and confirmed that it meets the user requirements.

? **Development tools knowledge**

This project is using Microsoft Visual Basic 6.0 (VB), Microsoft SQL Server 2000, and Microsoft SQL Server CE. VB is a very powerful development tool for developing Windows environment information system. It is easy to use and provides graphical user interface. Microsoft SQL Server 2000, Microsoft SQL Server CE is used as database for this system; it is a database program suitable for storing records which data are not very large. Seagate Crystal Report is a powerful tool for generating report. It provides component to be added in VB to call out its report. Report is easy to design and also has the print report function; therefore no extra coding is needed to do this task.

CHAPTER 8

CONCLUSION

Chapter 8: Conclusion

Valuable knowledge has been gained throughout the development of the system. These include skills in programming with visual development environment, programming database manipulation, Remote Data Access and server configuration.

This project gives me an opportunity to build a full application from scratch. It is a great challenge to develop a system alone. From this project, I have gained invaluable knowledge and experience during the progress of it. The knowledge which I obtained from university in these three years time gives me a strong foundation to take this project as long as to complete it. In addition, useful techniques which have learned are applied to this project.

This thesis makes me realize that tertiary education provides the foundation of computer science and information technology to undergraduates. There are more things to learn and experience in this fast growing world of information age. One has to constantly update oneself to keep up with the changing technology.

In view of the above, the project has created wide opportunity for individual who is creative and innovative to further modify and tailor the system to individual needs. The development tools and languages used have potential to grow in the future as well.

All in all, this thesis has armed me with invaluable knowledge and experience. As a result, I am better prepared to face future challenges in life.

APPENDIXES

Appendix A: User Manual

Introduction

WORS - Wireless Ordering & Reservation System is a combination Point of Sales System and Management Information System. This system will keep track the user information, sales record, user working record and generate sales report.

Part I: The Center POS system

1. Security Logon

WORS is provided with a main screen every time the application is started. This main screen is showing out the WORS system Logo. This time you can choose whether you want to login into the system or cancel to exit this system.

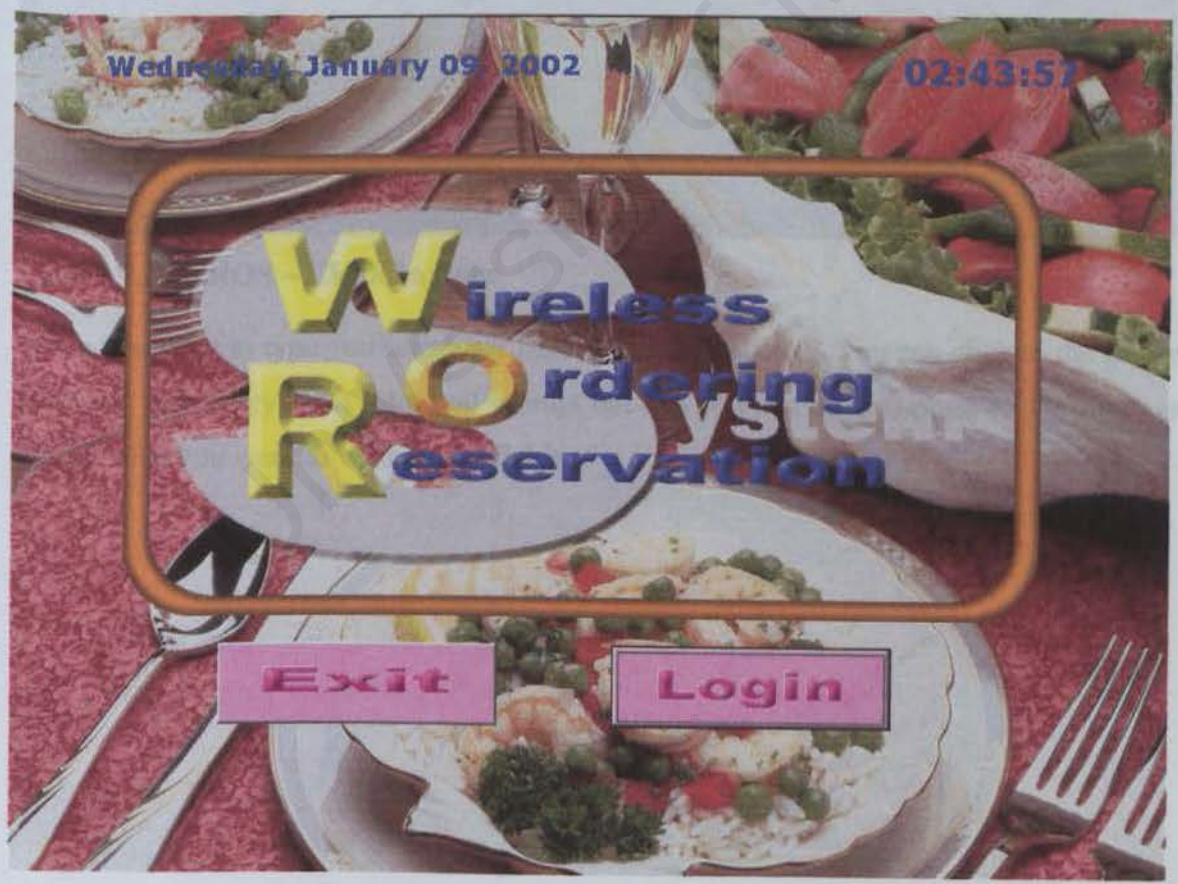

Figure 9.1 WROS - Main Page

After the login button is pressed, the clock in form is provided. The fields that are required for the login are 'User ID' and 'User Password'.

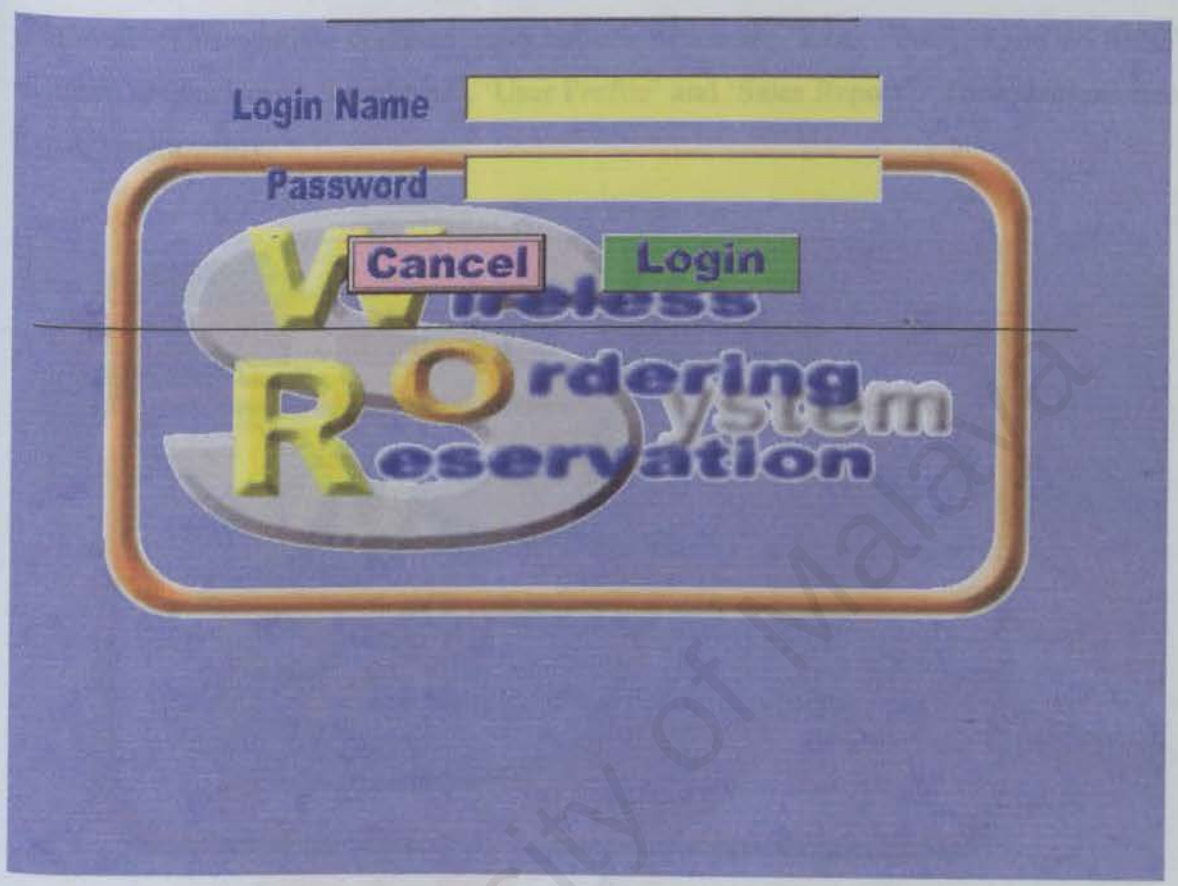

Figure 9.2: WROS – Clock In Page

When you want to type you user Id or password into the fields, you can click to the field of the label, then a keyboard form will prompt out and you just need to press on the keyboard button what you want to write in the fields.

2. Main function Window

After you have successfully logon to the system, the main function window is displayed. This window contains eight buttons which are 'Exit', 'Bar', 'Point Of Sales', 'Kitchen', 'Clock out', 'employee', 'User Profile' and 'Sales Report'. These buttons have it own functionality.

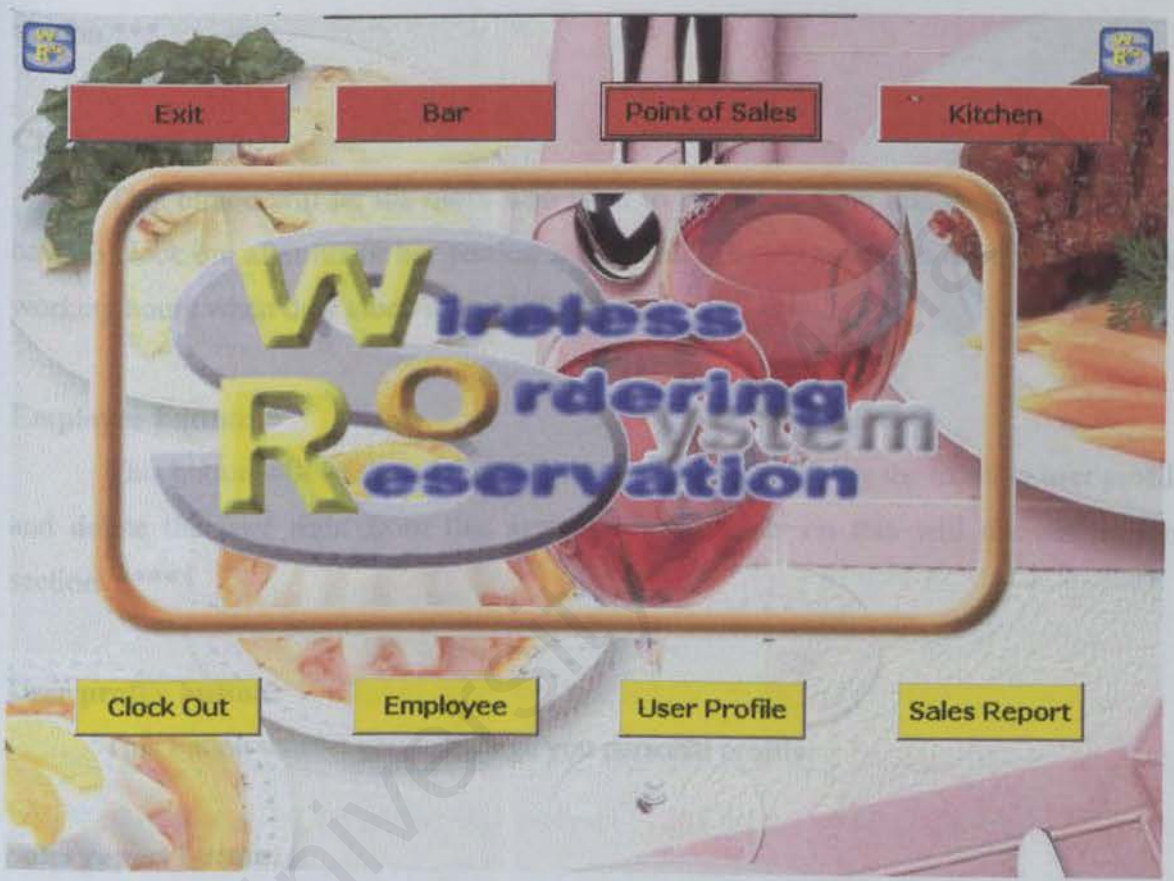

Figure 9.3: WROS – Main Function Page

Exit button:

When you press this button you will go to the main window. The purpose is to give another user to clock on to this system.

Bar button:

This button will let you go to the bar display system. This will discuss in section ***

Point of Sales button:

This button will let you go inside the point of sales system which let you to make an ordering process and payment process.

Kitchen button:

This button will let you go to the kitchen display system. This will discuss in section ***

Clock out button:

This button will let the users who want to clock out from this system. The users have to clock out after his or her section is finished. The purpose is to keep track the user working hours when they clock in until clock out.

Employee button:

This button will let the admin to add a new user, modifying the existing user profile and delete the user right from this system. The details on this will discuss later in section .*****

User profile button:

This button will let you to change you personal profile.

Sales report button:

This button will let you go into the report window which will process the report in a duration time.

3. Bar Display System Module

After you click on the bar button, the window in below will appear.

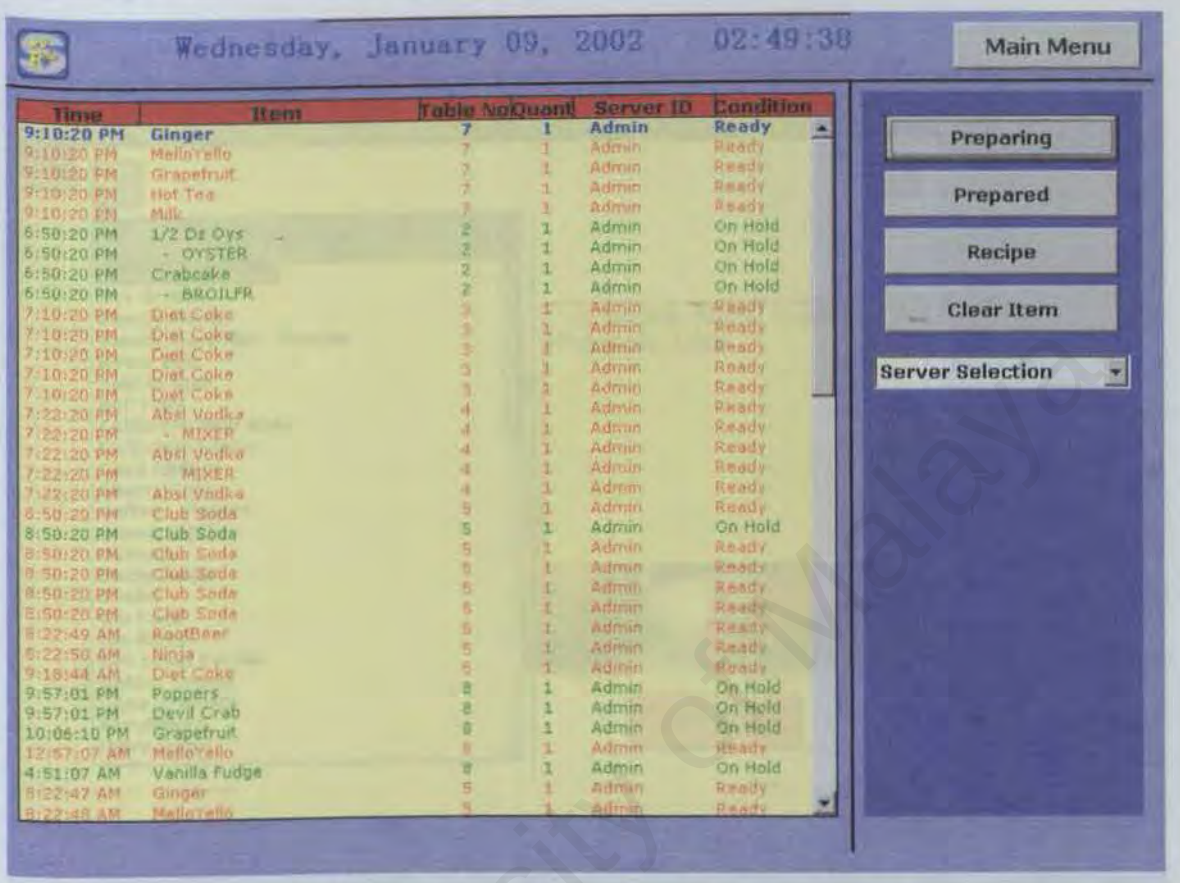

Figure 9.4: WORS – Bar Display page

On the window, you can see a large list view which is showing the items which have been ordered by the waiter and waitress. The list will use first come first served method. The items showing **'ready'** state are the items that have not yet prepared. And the items showing the **'On-Hold'** state are the items on preparing. When the bar tender want to prepared the items of drink they have to touch on the item the want to prepare and then touch on the preparing button then the item in the list view will change the state into **'On-Hold"** and the font color will changed from red to green. After the item have been prepared, the bar tender just need to touch on the item and touch the button prepared. After that, the item will disappear from the list.

The Clear Item button is used when the order item is running out of stock. And the server selection Combo Box is let the bar tender to sending message to the active user in this system. The bar tender just need to scroll down the user list and the message box will

appear in to bottom of it. After the send button has been touch the message is sending to the user.

The Recipe button is to show up the recipes window.

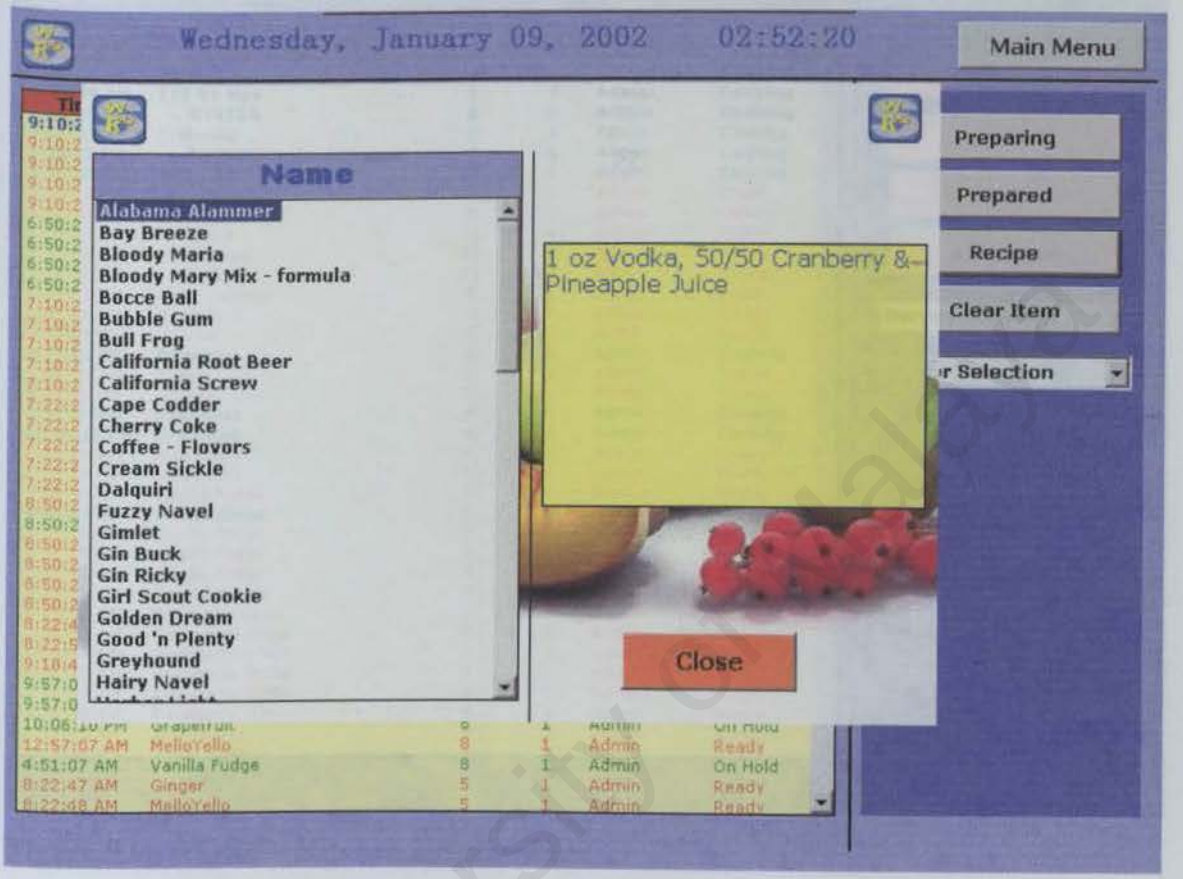

Figure 9.5: WORS – Recipes Page in Bar

Finally the Main Menu button is to let you go to the main window as in figure 9.3

4. Kitchen Display System Module

After you click on the kitchen button on the main window, the window in below will show up.

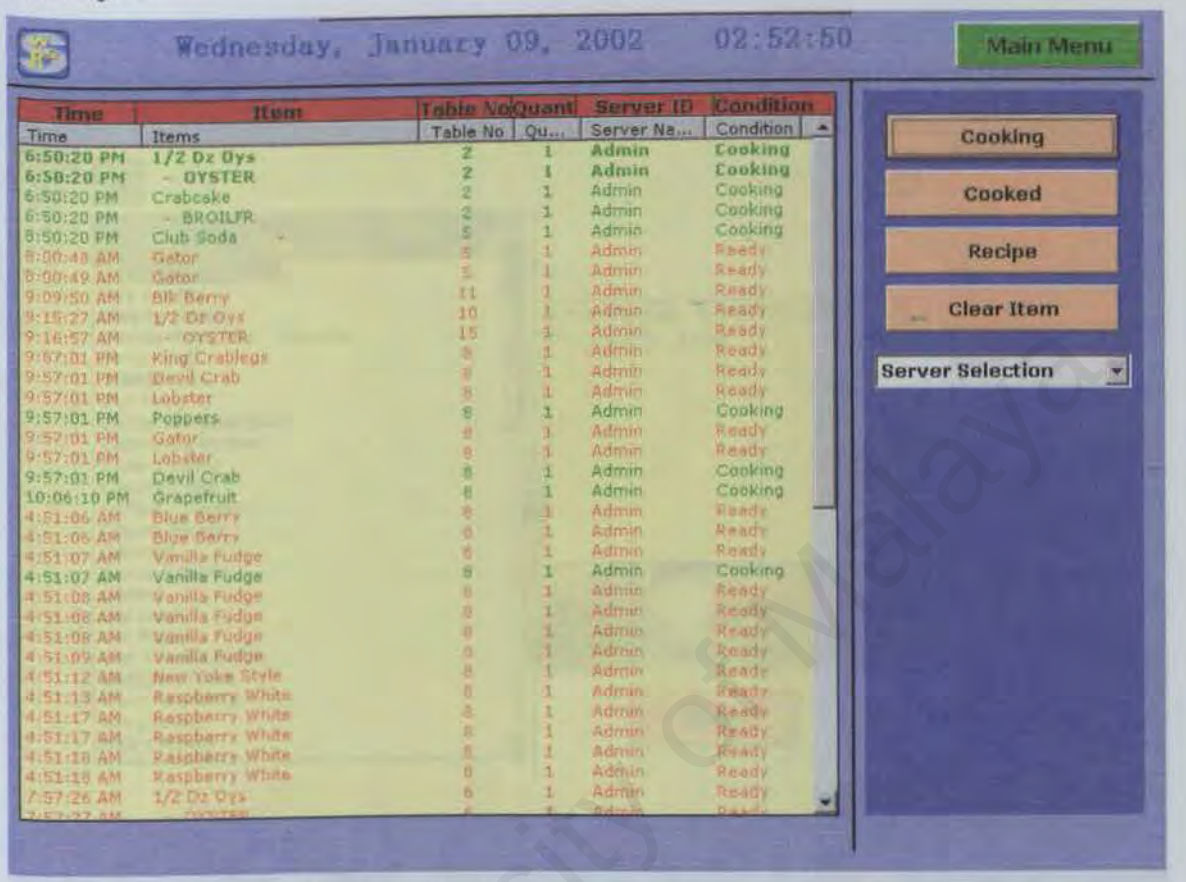

Figure 9.6: WORS – Kitchen Display Page

On the window, you can see a large list view which is showing the items which have been ordered by the waiter and waitress. The list will use first come first served method. The items showing '**Ready**' state are the items that have not yet prepared. And the items showing the '**On-Hold**' state are the items on preparing. When the cook want to prepared the items of drink they have to touch on the item the want to prepare and then touch on the preparing button then the item in the list view will change the state into '**On-Hold**" and the font color will changed from red to green. After the items have been prepared, the cook just need to touch on the item and touch the button prepared. After that, the item will disappear from the list.

The '**Clear Item**' button is used when the order item is running out of stock. And the server selection Combo Box is let the bar tender to sending message to the active user in this system. The cook just need to scroll down the user list and the message box will

appear in to bottom of it. After the send button has been touch the message is sending to the user.

The '**Recipe**' button is to show up the recipes window.

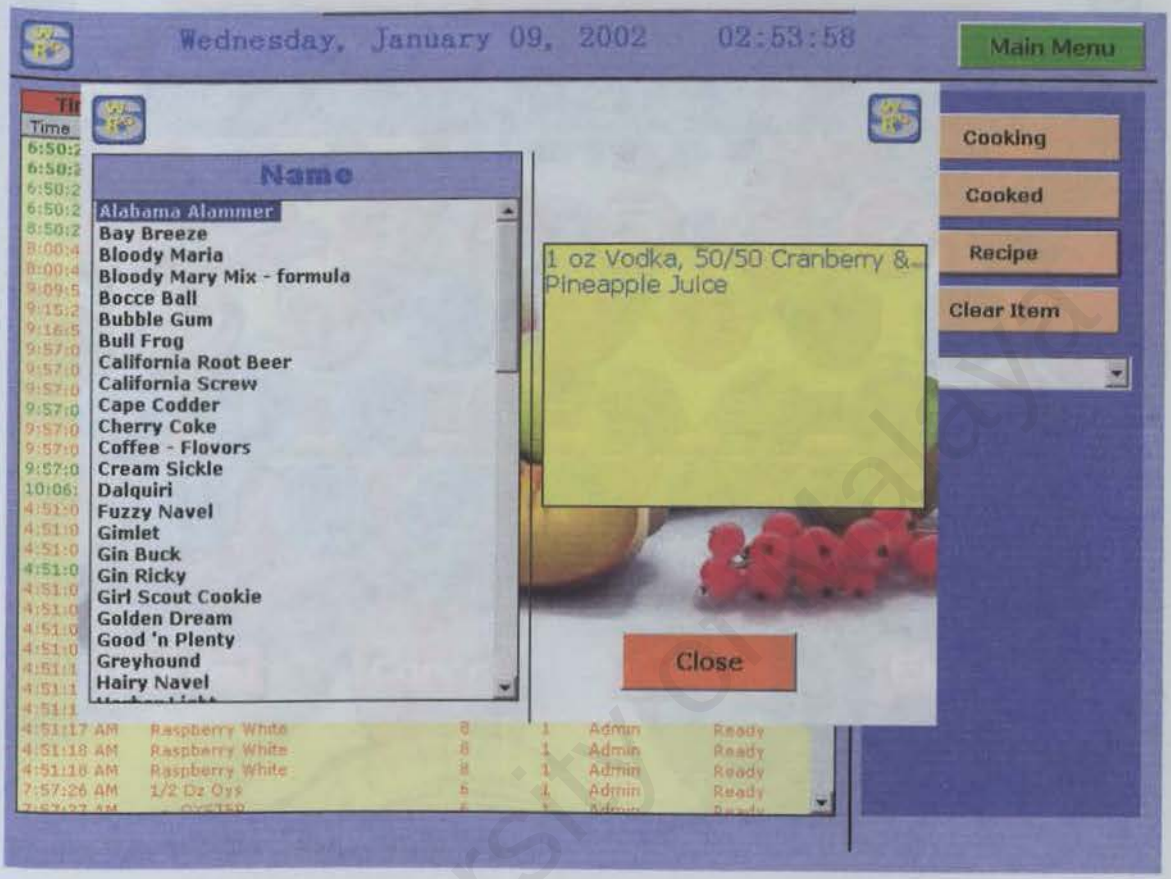

Figure 9.7: WORS – Recipes Page in Kitchen

Finally the '**Main Menu**' button is to let you go to the main window as in figure 9.3

5. Point Of Sales module

When you touch a button on Point Of Sales, the window 'select table ' will show as figure below:

Figure 9.8: WORS – Select Table Page

The red circle button shows that two or more tables are group together. It is because a group of customer sitting more than one table.

The chocolate circle button shows that a table is sitting by customer.

The blue circle button shows the table is currently available.

How to group table:

If you want to group two or more table, you need to press to the group button and then touch on the table no. after that press 'Enter' button to close group module.

How to take order:

Touch on the table button regarding to the table number, than the window no guest in figure 9.9 is showing up.

Figure 9.9: WORS – No Guest Page

You need to enter a number of customer is that table. After that, pressing to the **'Enter'** button link to **'Item Order'** window in Figure 9.10.

Figure 9.10: WORS – Item Order Page

The main item group is on the left and the sub item is in the middle and finally the item selected is on the right. When the main item is touched, the sub item menu will showing up the entire sub item under each main item. After that you need to find out the item you need. Each time you press on the button in sub main item, the item will display on the ordered item field. If you select a wrong item, then you can delete it order item field. You need to touch the item on the 'ordered item' field and touch to the delete button next. The item will delete from list. The clear button let you to clear the entire item on the list.

At the top of the screen, there are four button which are cancel button, recipe button, pay button and print button.

Cancel button:

The cancel button is to cancel the ordering tack and back to the select table window in figure 9.8.

Recipe button:

When the recipe button is press then the recipes window will pop-up as figure 9.11

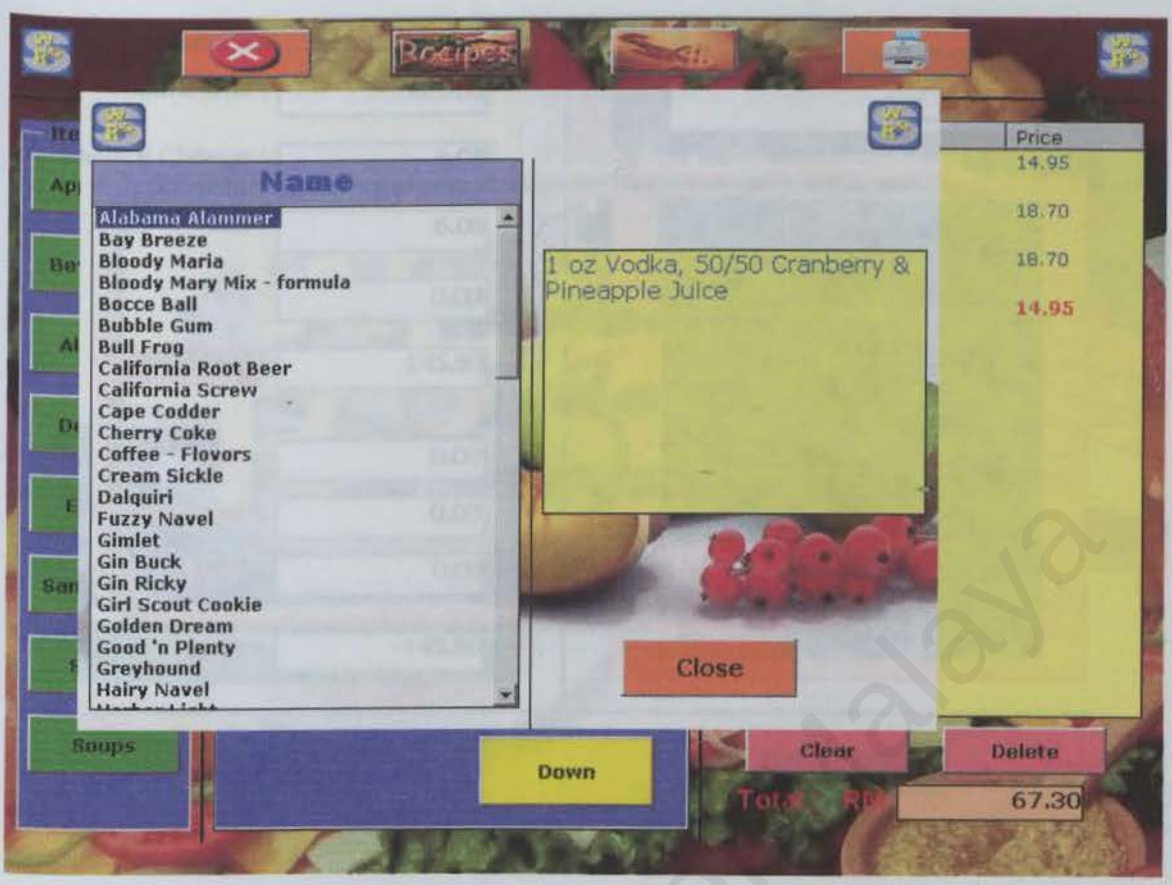

Figure 9.11: WORS – Recipe Page in Item Order Page

Print button:

The print button is to print out the entire items and prices to show to the customer when the customer is calling a bill.

Pay button:

When the customer pay the bill then you need to touch on the pay button and the payment window will show up as figure 9.12

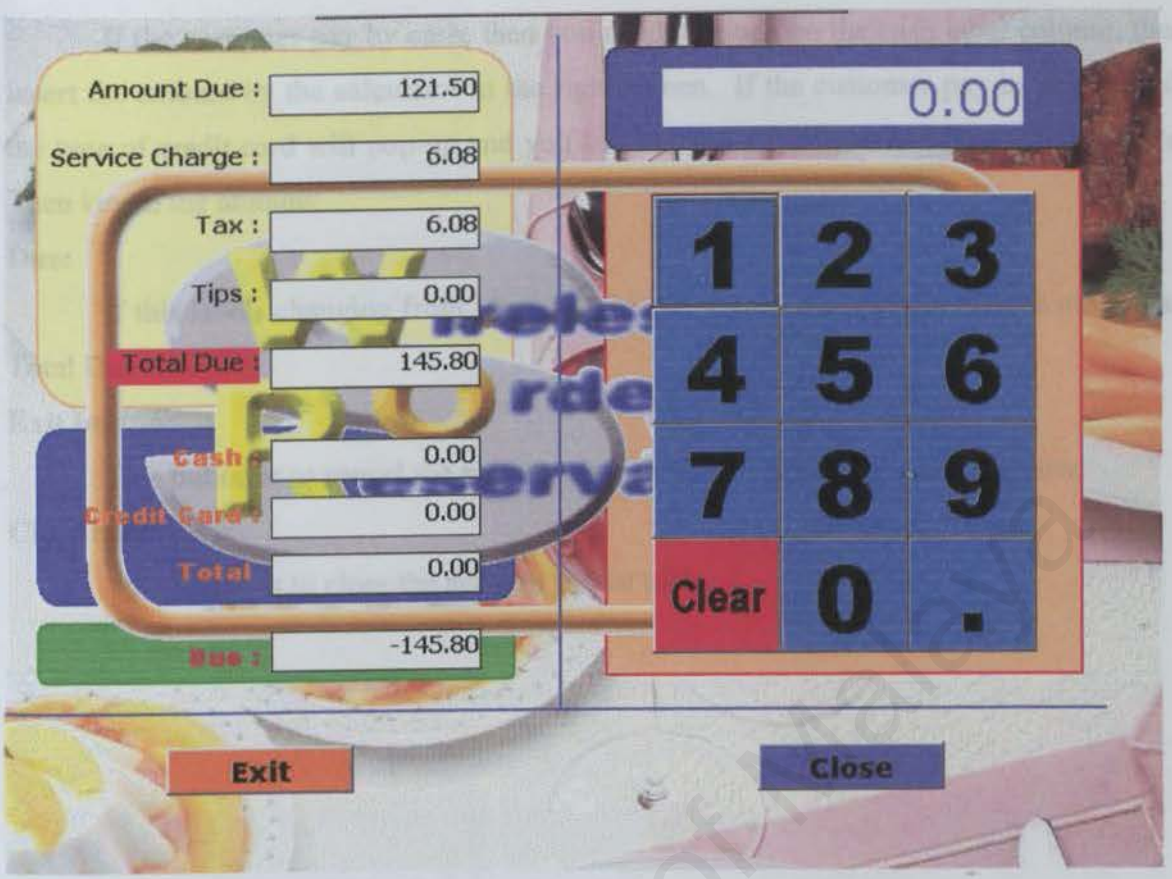

Figure 9.12: WORS – Payment Page

Amount Due:

The column 'Amount Due' contains the cost of the entire item before any charge and tax added.

Service charge:

Total service charge is charged.

Tax:

Total tax is charged.

Tips:

If the customers give you extra tips, you need to record in this system. You need to touch on the tips label or column and then insert the amount of the tips in the right of the window.

Total due:

This column contains the amount money need to pay by customer.

Cash and credit card:

If the customer pay by cash, then you need to touch on the cash label column, then insert the amount by the calculator in the right screen. If the customer pay by credit card, the type of credit card will pop-up and you can touch the type match with the customer's. Then key in the amount.

Due:

If this labels changing from 'due' to 'change' means those totals receive more than Total Due.

Exit button:

This button is to cancel the payment window and back to the order window.

Close button:

This button is to close the account in that table.

6. Add and Edit Employee Profile Module

When you touch on the employee button, then the window as figure 9.13 shown:

Figure 9.13: WORS – Add and Edit Employee Profile Page

This window will give you add a new user, modifying the existing user and delete the existing user. If you want to show the entire user by different user by different user level, then you can scroll down the user level box and select the level you want to display and the status of the user. Then the selected user level and status will show on the list field.

Add new user:

Touch on the '**Add New User**' button is a first step; the screen in figure 9.14 will show.

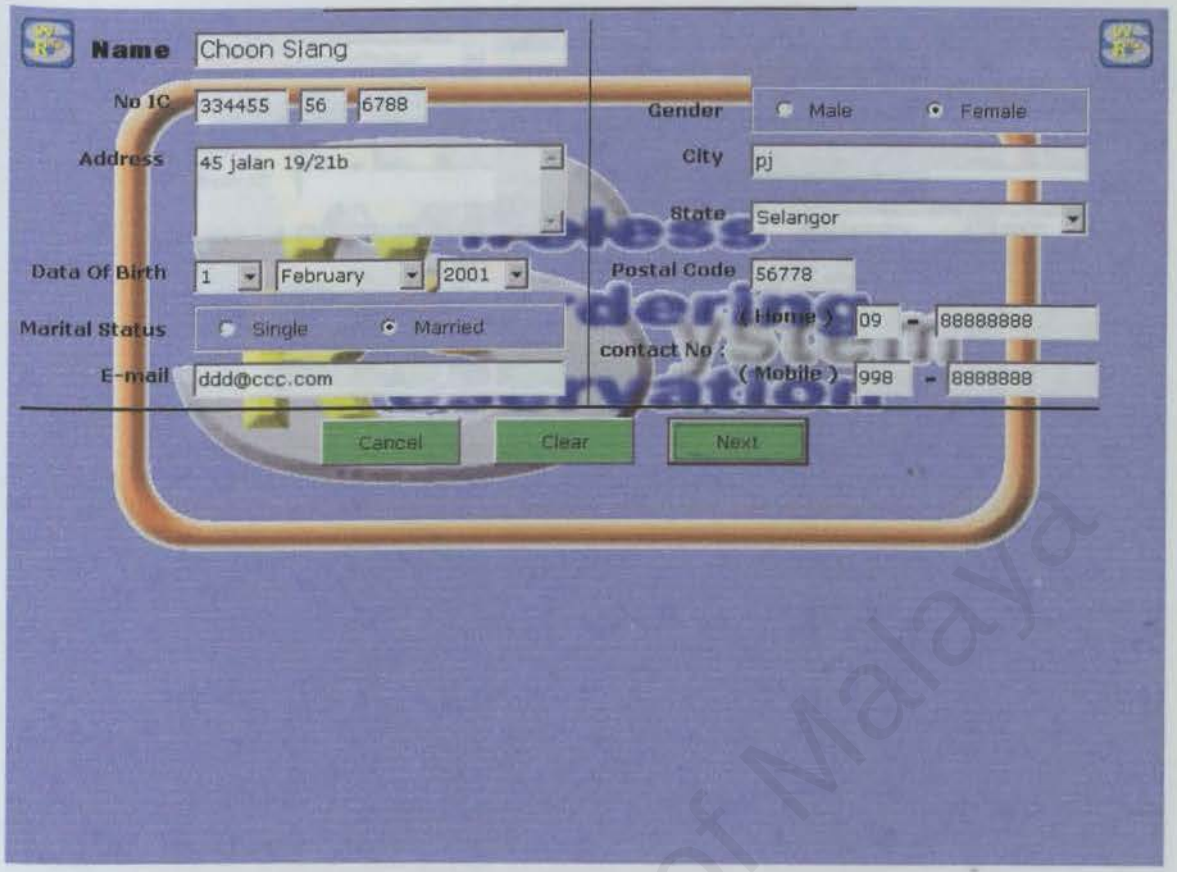

Figure 9.14: WORS – Add New User Page (first page)

You need to fill in all the fields before continue to the next page. Each filling fill will pop-up a keyboard window when the field is clicked. If you want to cancel or clear this form, you just need to press **'Cancel'** and **'Clear'** button. Otherwise, you press next button to continue to the second form which is shown as figure 9.15

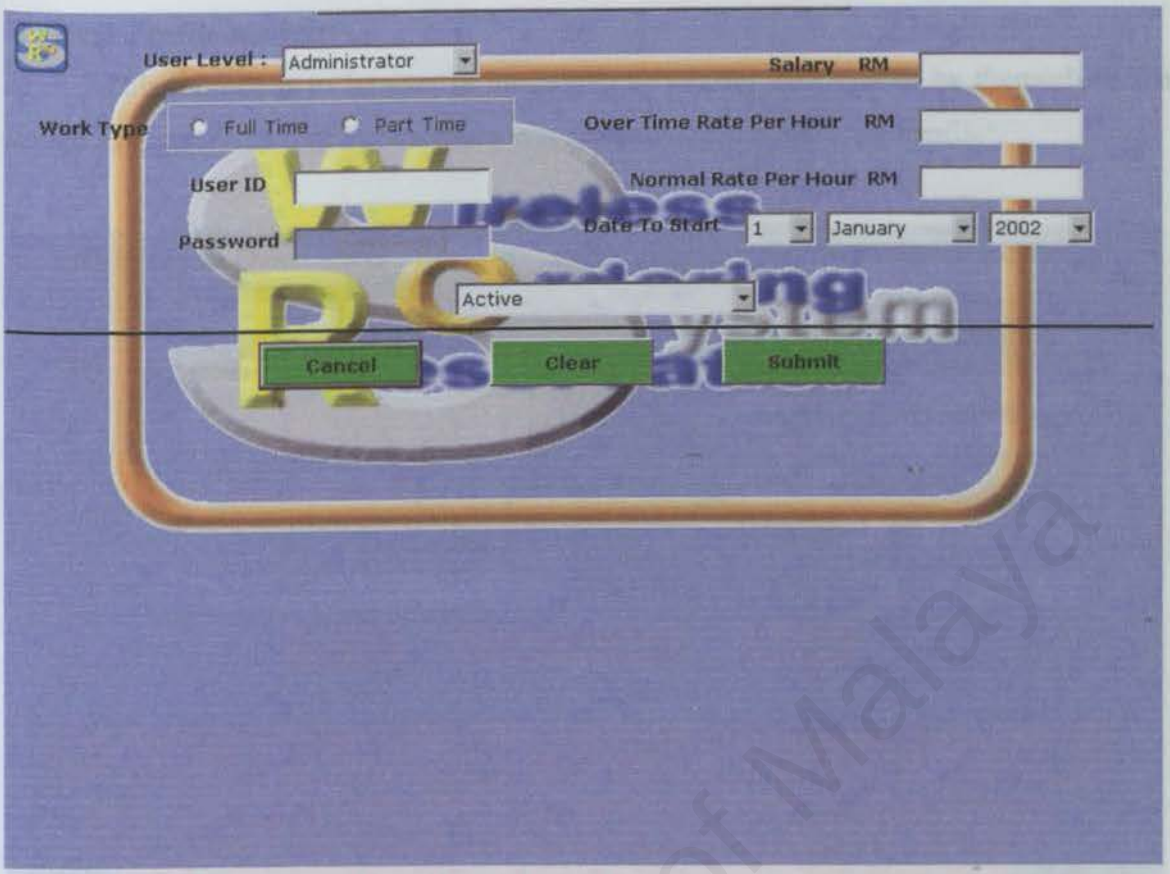

Figure 9.15: WORS – Add New User Page (Last Page)

After you filling the entire fields, you can continue and touch on the submit button, then the profile will save into database.

Modifying or Edit User Profile button:

This module will pop-up the same screen as in figure 9.15 and figure 9.16 and the way to modifying the profile is to change the field item.

Delete Existing User button:

Touch or select on the list field the user you want to delete and then touch on the delete button.

Done Button:

To quit this windows and back to the main function window as figure 9.3.

7. User Profile module:

This module is to let user to modifying or editing their profile by themselves. The screen as figure 9.16 will shown when you press on the button 'User Profile'.

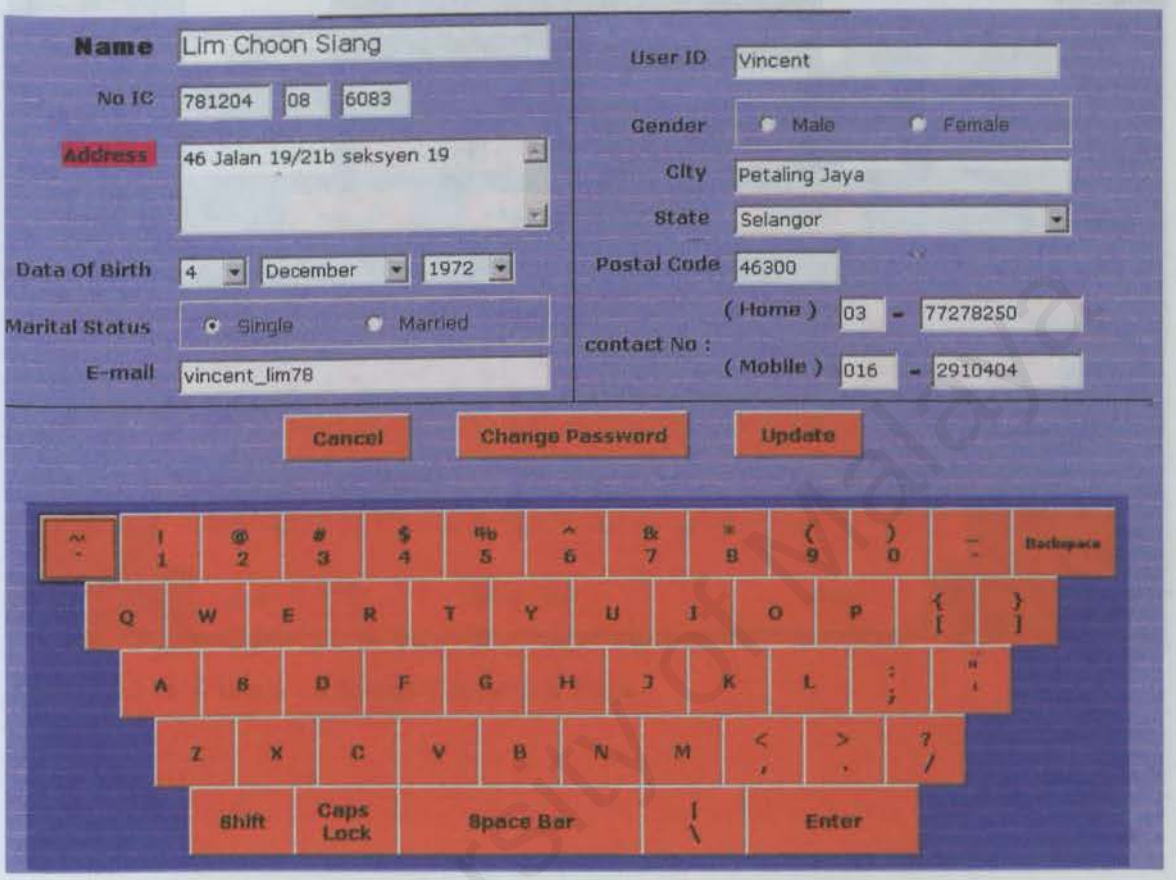

Figure 9.16: WORS – User Profile Page

If the user want to change their password, just press on the 'Change Password' button then the change password screen will pop-up as figure 9.17

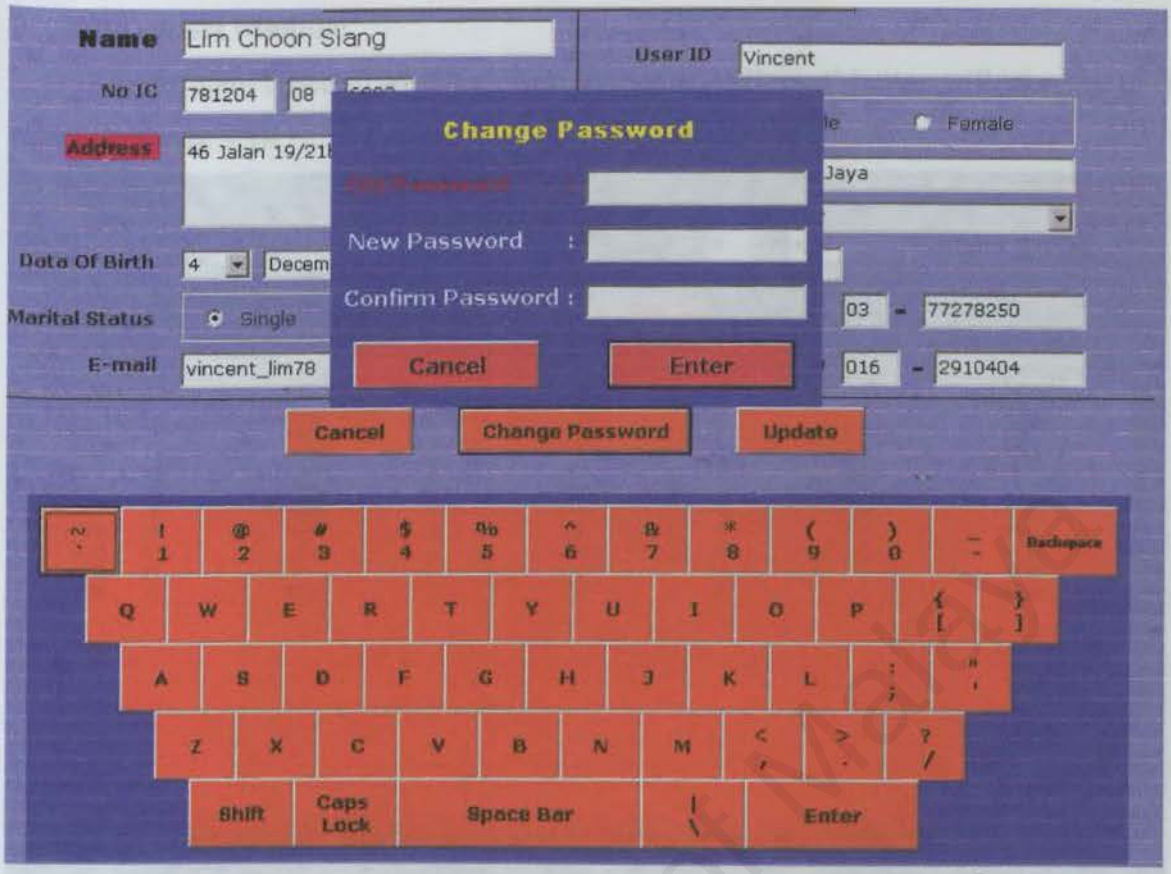

Figure 9.17: WORS – Change Password Page

8. Sales report Module:

In the main function window, click on the 'Sales Report' button will take you to the screen as figure 9.18.

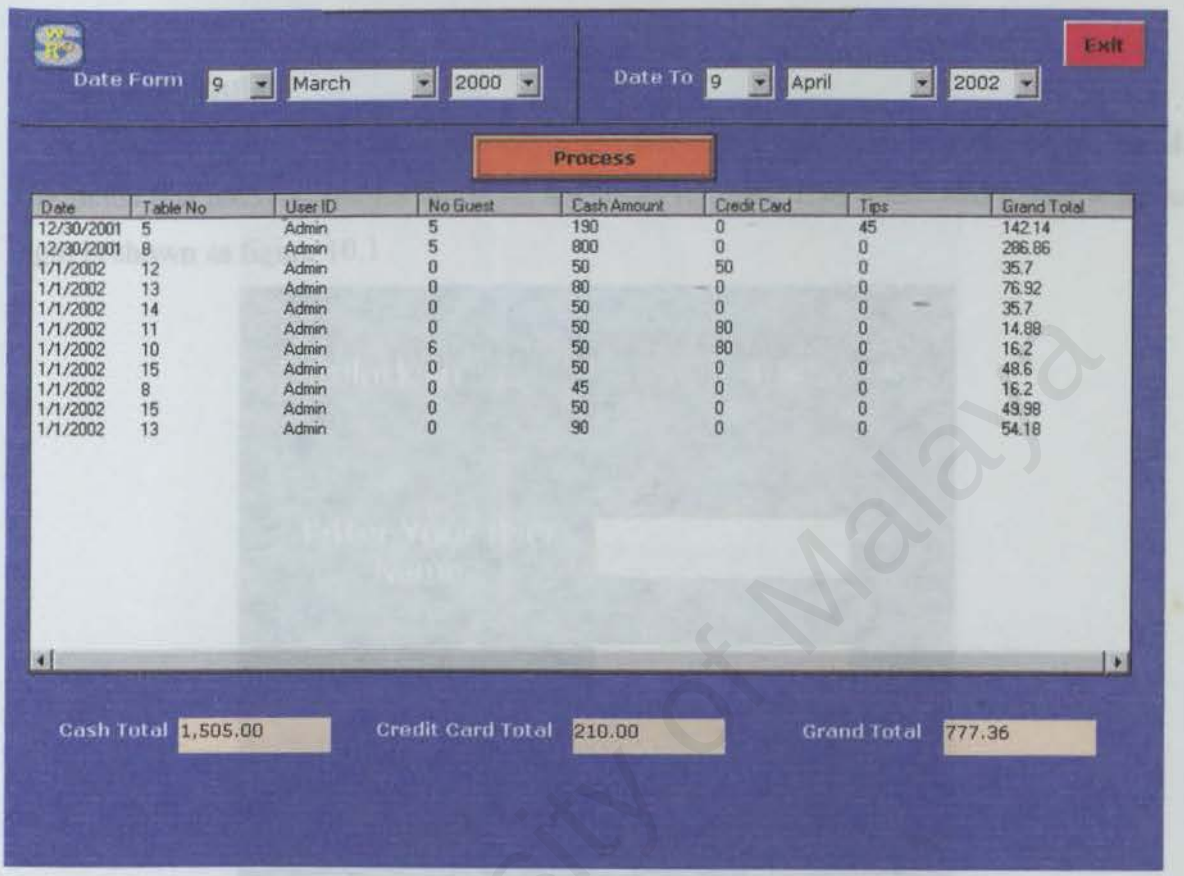

Figure 9.18: WORS – Sales Report Page

You need to select duration to process the report which are date from and date to. After that, press on exit button to terminate this window.

Part II: Mobile Ordering System

This section gives an overview of the mobile ordering system.

1. Login Module

WORS is provided with a security login screen every time the application is started. The fields that are required for the login are 'User ID' and 'User Password'. The window login is shown as figure 10.1

Figure 10.1: Mobile WORS - Clock In Page

2. Point Of Sales Menu module

After the login is successful then the select table window will appear as figure 10.2

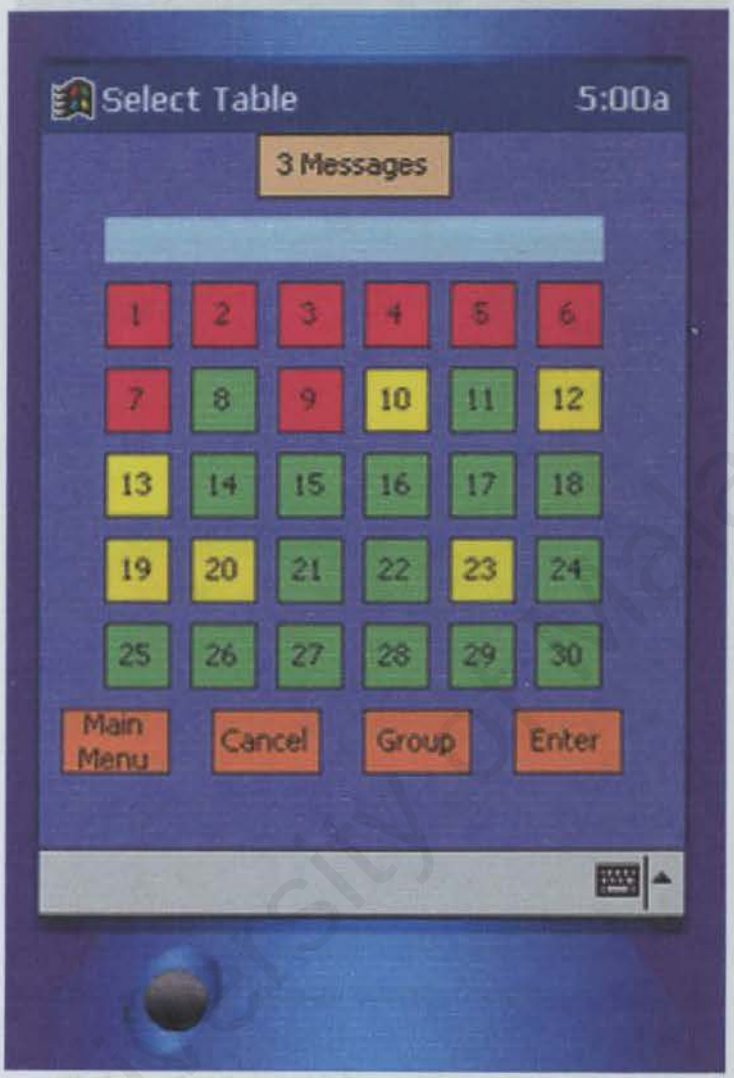

Figure 10.2: Mobile WORS - Select Table Form

Message Button:

When there is a message arrives, the message button will visible in the screen. Click on the '**Message**' button, the screen as figure 10.3 will shown.

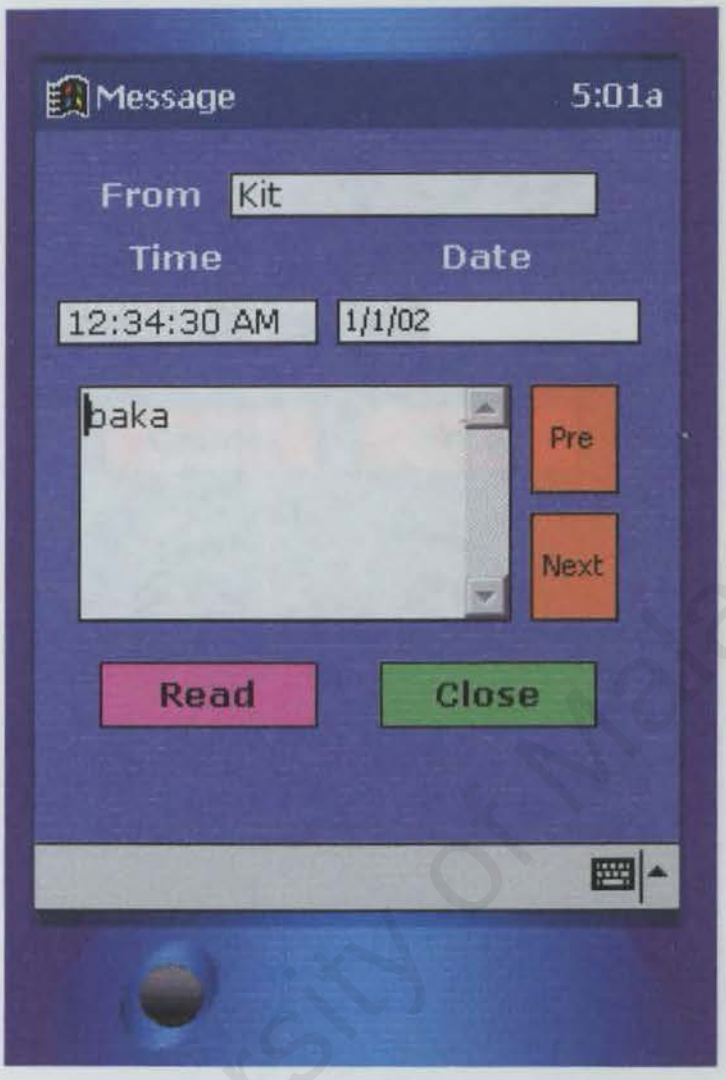

Figure 10.3: Mobile WORS - Message Page

This screen will show the time and from whom the message is sent. If the message is more than one, you can press on the next button to go to the next message and pre is move previous. If you press read button, this message will consider read and clear form the list.

'**Close**' button is to close this window.

Figure 10.4: Mobile WORS - No Guest Page

The function of this is to insert no of guest in a table.

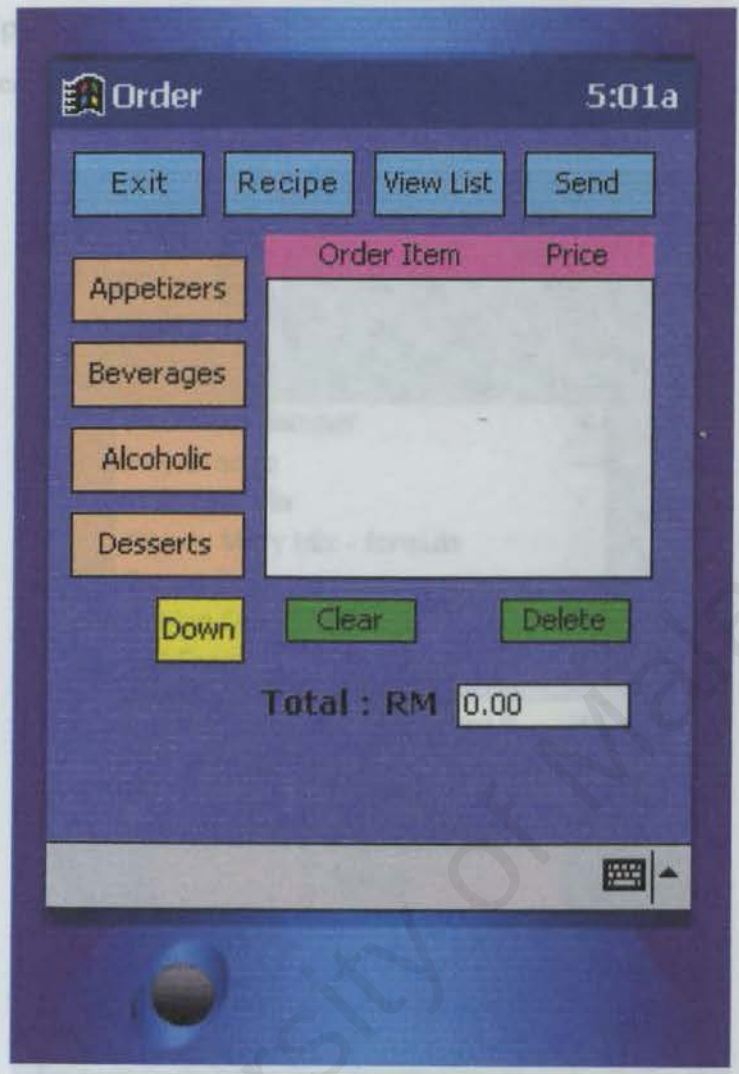

Figure 10.5: Mobile WORS – Item Order Page

This form is same functioning with the form is figure 9.10 in part I.

3. Show Recipe

The screen as figure 10.6 will appear when you press on the recipe button in the order form.

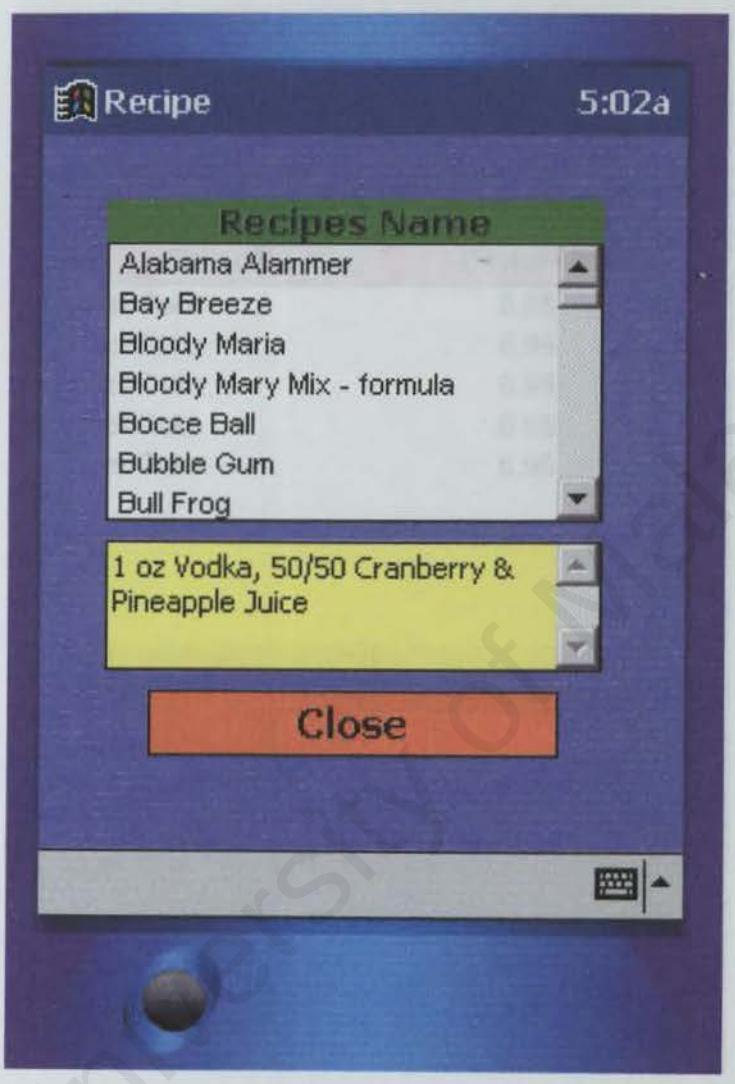

Figure 10.6: Mobile WORS - Recipe Page

4. View list button:

This button is used to display an enlarge view for the items which have been select in a list. The screen is shown as figure 10.7.

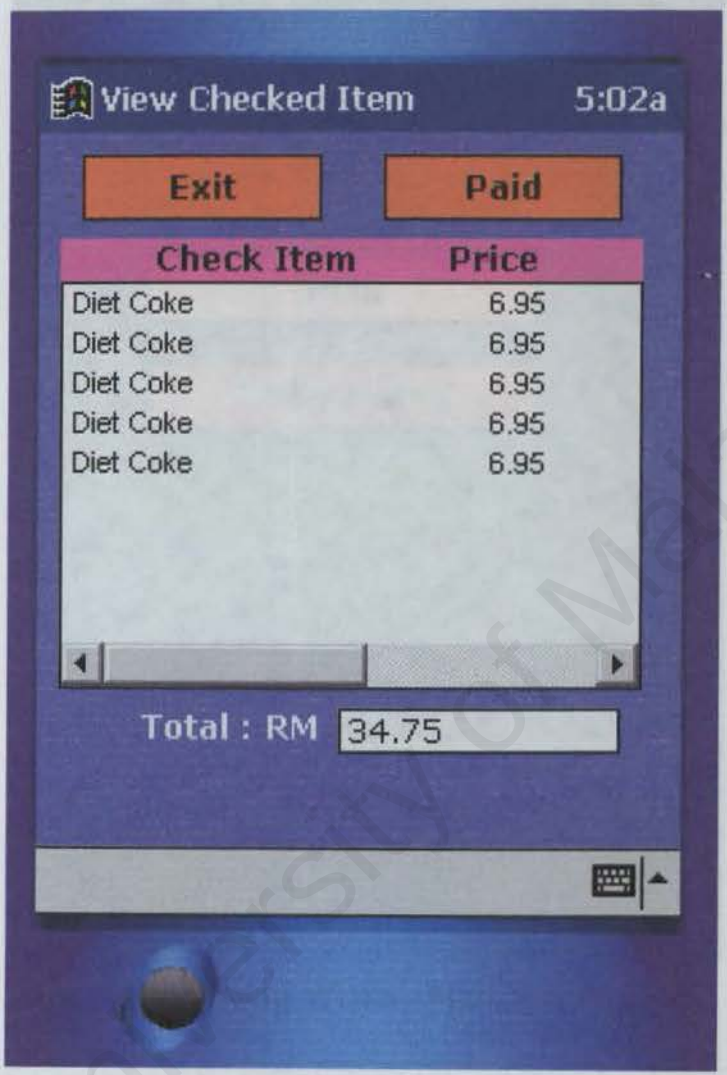

Figure 10.7: Mobile WORS - View Check Item Page

5. Main Function Screen:

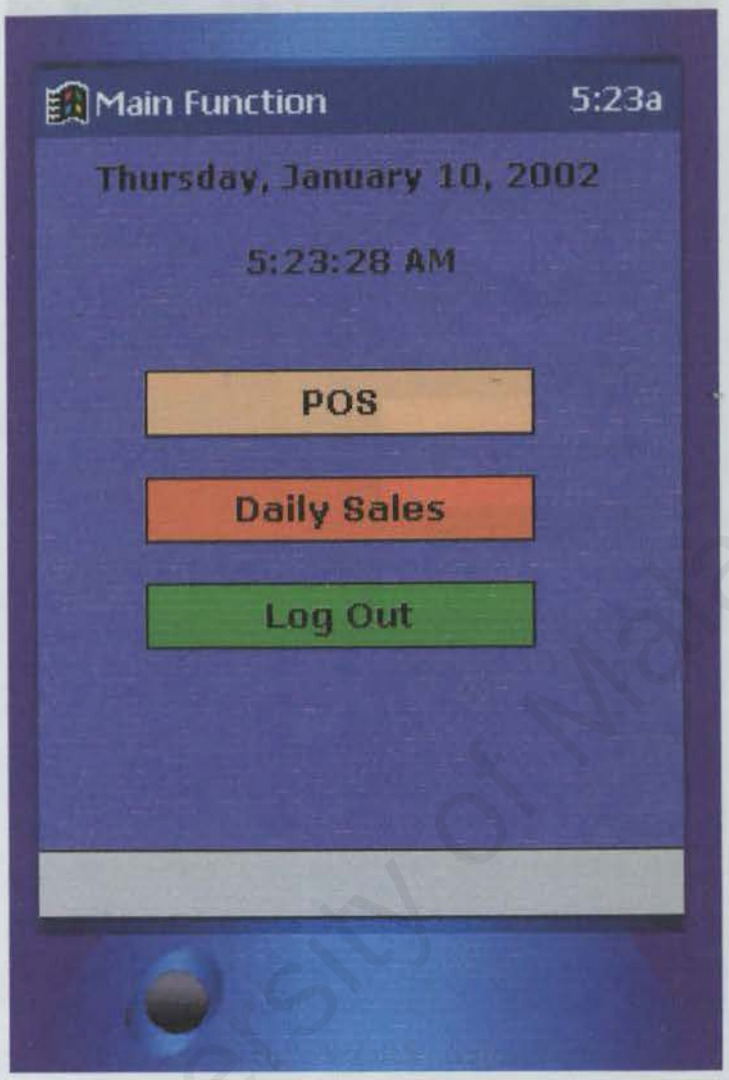

Figure 10.8: Mobile WORS - Main Function Page

This window contains three main function which is POS (Point Of Sales system), daily sales and Logout.

Pos button:

This will move the screen as figure 10.2.

Daily sales:

This button will move to a form that shows the daily sales for the existing user. The form is shown as figure 10.9.

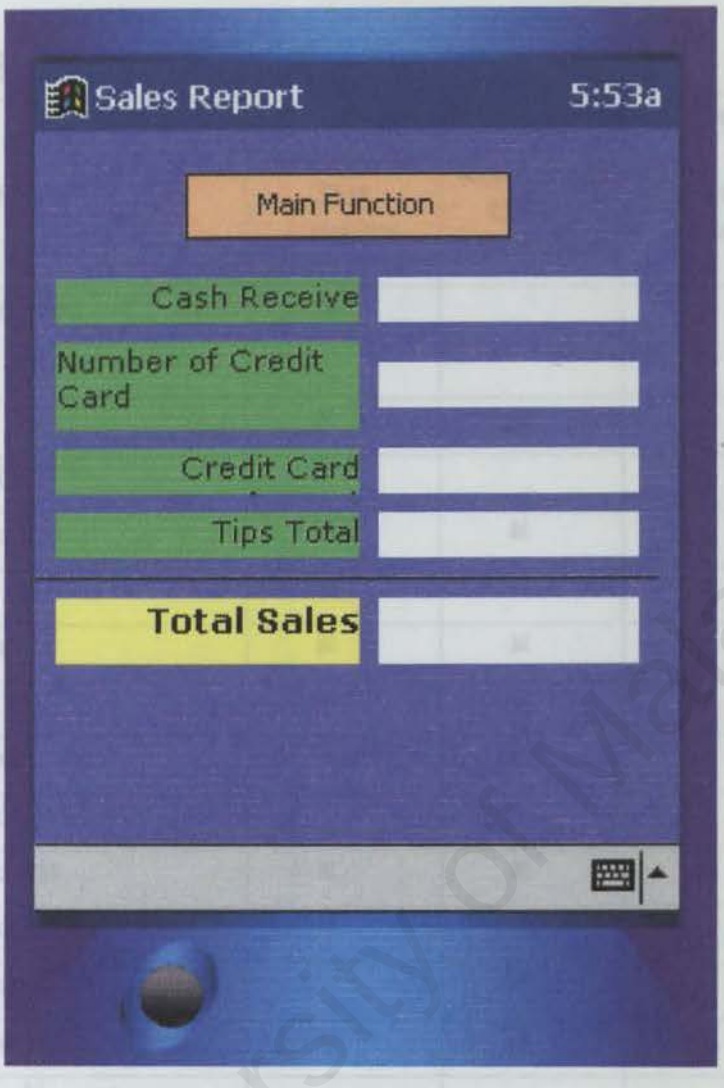

Figure 10.9: Mobile WORS - Sales Report Page

Logout button:

Logout is needed to prevent unauthorized user to use this application.

Appendix B:

Features	Similar System Review			
	Ameranth's 21st Century Restaurant	Restaurant Coffee Terrace	Execu / Touch	WORS
User Login & Password Authentication	✖		✖	✖
Item modifiers	✖	✖	✖	✖
Inventory Control			✖	
Central POS system	✖	✖	✖	✖
Printing Receipt	✖	✖	✖	✖
System Administrator	✖	✖	✖	✖
Payment Process	✖	✖	✖	✖
Management Report	✖	✖	✖	✖
On Air Reservation purpose				✖
Authorize credit cards	✖	✖	✖	✖
Wireless handheld Pos Terminal	✖			✖
Wired Pos Terminal		✖	✖	
Order by table and seat number	✖	✖	✖	✖
Kitchen or bar display system				✖
Touch Screen Display (Graphical User Interface)	✖	✖	✖	✖
Routes orders to designated printers	✖	✖	✖	✖
Graphical Table Management			✖	✖
Back Office Accounting			✖	
Food or Drink prepared Notification				✖
Wireless Payment Printer	✖			
Routes orders to kitchen & bar	✖	✖	✖	✖

Table 3.0 Summary of the Similar System Review

	Windows/98	Windows/NT 4.0	Windows/2000	RedHat Linux 6.2	SunOS on PC	Linux on SPARC or Alpha or Itanium
Clusterable	no	no	Advanced server and data center: yes	Beowulf Piranha Steeleye	Beowulf	Beowulf See the avalon page
Office Automation?	MS-Office Wordperfect	MS-Office Wordperfect	MS-Office Wordperfect	StarOffice WordPerfect	StarOffice?	StarOffice?
Fat-16	yes	yes	yes	yes	no	yes
Fat-32	yes	no	yes	yes	no	yes
NTFS	no	yes	yes	yes	no	yes
HPFS	no	yes	yes	yes	no	yes
ext2 file system	no	no	no	yes	no	no
address space	2 Gbytes	2 Gbytes	Advanced Server: 8 GB Data Center: 64 GB	4 Gbytes in 2.2 and earlier kernels, but 64 bit integers are supported 64 Gbytes in 2.4 kernels	4 Gbytes	Terabytes
SMP	no	yes, 4 CPUs	yes, 8 CPUs Data Center, 32 CPUs	yes, 4 CPUs	?	yes, 256 CPUs
NIS client	no	no	?	yes	yes	yes

NIS server	no	no	?	yes	yes	yes
Kerberos client	no	no	not compatible with UNIX	yes	yes	yes
NFS client	no	no	optional with SFU	yes	yes	yes
NFS server	no	no	optional with SFU	yes	yes	yes
NetBEUI client	yes	yes	yes, but breaks with early versions of Samba	yes	yes	yes
NetBEUI server	yes	yes	yes, but breaks with early versions of Samba	yes	yes	yes
Secure	no	no	no	no	no	no
Easy to use GUI	yes	yes	yes	yes	?	yes
Webserver	PWS (bundled with Front Page)	IIS	IIS	apache	apache	apache
Size of a full installation				1.7 GBytes		
bundled scripting	.bat files	.bat files	.bat files, sh	csh, sh, tcsh,	csh, sh, tcsh,	csh, sh, tcsh,

language				bash, perl, tcl,...	perl	bash, perl, tcl,...
Scalability: low end	slow pentium, 32 MBytes RAM	Pentium, 62 MBytes RAM	250 MHz Penitum	System-on-a-chip (we're an EE school, right?). Match box PC. The book says 4 Mbytes RAM, 80386 CPU.		
Scalability: high end				2.4 supports 4 GBytes RAM SuSE has a patch to 2.2.12 for 4 GBytes. 2.4 may support 64 GBytes of RAM on ia32!		8 Gbytes RAM
Journaling file system	no	NTFS and HPFS	NTFS and HPFS	yes, see ReiserFS		

Table 4.0 Comparison of Operating System

REFERENCES

References

[1] Netscape Communications. (2001). The SSL Protocol. Retrieved Jun 1, 2001 from the World Wide Web: http://www.netscape.com/newsref/std/SSL.html

[2] Netscape Communication. (1998). Introduction to SSL. Retrieved Jun 10, 2001 from the World Wide Web: http://developer.netscape.com/docs/manuals/security/Sslin/contents.htm

[3] WDVL. (1999). Secured Transmission (SSL, HTTPs). Retrieved Jun 23, 2001 from the World Wide Web: http://www.wdvl.com/Authoring/Tools/Tutorial/secure.html

[4] Rave Technologies. (2001). WAP Architecture. Retrieved Jun 23, 2001 from the World Wide Web: http://www.rave-tech.com/WAP/waparchitecture1.html

[5] WAP Forum. (1998). Wireless Transport Protocol Specification. Retrieved Jun 23, 2001 from the World Wide Web: http://www.wapforum.org/

[6] WAP Forum. (1998). Wireless Telephony Application Specification. Retrieved Jun 23, 2001 from the World Wide Web: http://www.wapforum.org/ .

[7] WAP Forum. (1998). Wireless Application Protocol Architecture Specification. Retrieved Jun 23, 2001 from the World Wide Web: http://www.wapforum.org/

[8] WAP Forum. (1999). Wireless Application Environment Specification version 1.1. Retrieved Jun 23, 2001 from the World Wide Web: http://www.wapforum.org/

[9] Murdoch Mactaggart. (1999). Introduction to cryptography, Part 4: Cryptography on the Internet. Retrieved Jun 26, 2001 from the World Wide Web: http://www106.ibm.com/developerworks/security/library/scrypt04.html?dwzone=security

[10] Angela Noether. (2001). Introduction to wireless technology and the IBM WebSphere Everyplace Suite. Retrieved Jun 27, 2001 form the World Wide Web: http://www.developer.ibm.com/devcon/marcc01.htm

[11] Web Tools. (2001). WAP Security: Little Browsers Need Big Protection. Retrieved July 6, 2000 from the World Wide Web: http://www.webtools.com/story/security/

[12] WAP Forum. (1999). Wireless Transport Layer Security Specification Version 1.1. Retrieved July 2, 1999 form the World Wide Web: http://www.wapforum.org/

[13] Kendall, E. K., & Kendall, E. J. (1998). System Analysis and Design (4th ed.). New Jersey: Prentice Hall.

[14] Pfleeger, S. L. (2001). Software Engineering Theory and Practice (2nd ed.). Upper New Jersey: Prentice Hall.

[15] Anderson, P., et al. (1999). Professional Active Server Pages 3.0. Birmingham: Wrox Press.

[16] Soo, M. F., Wei, M. L., Watson, K., & Wugofuki, T. (2000). Beginning WAP, WML, and WMLScript. Birmingham: Wrox Press.

[17] Deitel, H. M., Deitel, P. J., & Nieto, T. R. (1999). Visual Basic 6 How To Program. New Jersey: Prentice Hall.

[18] Whitten, J. L., Bentley, L.D., & Dittman, K. C. (2001). Systems Analysis And Design Methods. New York: McGraw-Hill Irwin.

[19] Deitel, H. M., & Deitel, P. J. (1999). Java How to Program. New Jersey: Prentice Hall.

[20] Schneider, D. I. (1999). An Introduction to Programming Using Visual Basic 6.0 (4th ed.). New Jersey: Prentice Hall.

[21] Gallaugher, J. (1996). The Critical Choice of Client Server Architecture: A Comparison of Two and Three Tier Systems. Retrieved July 7, 2001 from the World Wide Web: http://www2.bc.edu/~gallaugh/research/ism95/john.gallaugher.

[22] Fastie, W. (1999). Understanding Client/Server Computing. Retrieved July 7, 2001 from the World Wide Web: http://www.officewizard.com/books/clientserver/ClientServerComputing.htm

[23] Holsberg, et al. (1999). FreeBSD Vs Linux Vs Windows NT, 2000. Retrieved July 12, 2001 from the World Wide Web: http://www.cdrom.com/~rab/bsd_chart.html

[24] IBM Corporation. (1996). Advantages of OS/2 Warp Microsoft NT 4.0 Workstation. Retrieved July 12, 2001 from the World Wide Web: http://www-4.ibm.com/software/os/warp/library/h1b7a.html.

[25] Deitel, H. M., & Deitel, P. J. (1998). C++ How to Program. New Jersey: Prentise Hall.

[26] Bowen, R., & Coar, K., et al. (2000). Apache Server. Indiana: Sams.

[27] Ameranth Wireless. (2001). 21st Century Restaurant. Retrieved July 8, 2001 from the World Wide Web: http://www.ameranth.com

[28] Execu/Tech. (2001). Touch Screen Point of Sale, Restaurant Management Software. Retrieved July 4, 2001 from the World Wide Web: http://execu-tech.com/.