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WXES3182: Projek Latihan Ilmiah II

Web Based Agent for Transaction of Mercantile - Security Measures

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ABSTRACT

Malaysia is a nation whose growth has been carefully shaped and guided by strategic five-year development master plans. Providing the ultimate backdrop to these programs is Vision 2020, a national agenda that sets out specific goals and objectives for long-term development. As a strategy to achieve the vision, Malaysia has embarked on an ambitious plan to leapfrog into the Information Age by providing intellectual and strategic leadership.

Electronic Commerce has shown its potential power to revolutionize industry processes, structures and redefine the competitive landscape for businesses around the world. It aims to shape an electronic business environment competitive with the major economic powers. E-Commerce has an enormous potential market that could be one of the driving force for future economic growth.

Realizing the fact stated above, this project was proposed. This E-Commerce project is to develop an interactive and attractive e-commerce web site for all local merchants and consumers. The aim of this project is to provide the opportunity of buying and selling computer products over the Internet for all malaysians. It also encourage the business and community to accept electronic business as an integral part of their daily lives.

In order to provide more efficient and better quality services, this project will be develop through several stages. Information was gathered on the development models, development tools and development strategies. Apart from that, research was done on the existing e-commerce applications to study the strengths and weaknesses of the current systems.

The Waterfall Model approach was chosen for the development of this project. It has five phases, which are requirement, design, coding, testing and operation. This approach was chosen because an e-commerce project required a well organized and structured planning of system design and implementation.

Throughout the development of the system, a lot of knowledge was gained such as knowledge in setting up Windows NT Server, Internet technologies, programming and concepts as well as using Microsoft SQL Server. Apart from that, knowledge also gained on how to implement effective security measures in e-commerce system. The security aspect been adapted in this project includes the use of Secure Socket Layer (SSL), Secure Electronic Transaction (SET), Digital Certificate and encryption.

Finally, all the problems faced and experiences gained during the system development should be useful in the future endeavors. This is because electronic commerce has shown its potential power to revolutionize industry processes, structures and redefine the competitive landscape for business around the world.

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LIST OF ABBREVIATIONS

ACE	Access Control Entries
ACL	Access Control List
ADC	Advanced Data Connector
ADO	ActiveX Database Objects
AMP	Asynchronous Multi Processing
ASP	Active Server Pages
B2B	Business-to-Business
B2C	Business-to-Consumer
CA	Certification Authority
CCNUMA	Cache-Coherent Non-Uniform Memory Access
CD	Compact Disc
CLI	Command Line Interface
CGI	Common Gateway Interface
COM	Component Object Model
CORBA	Common Object Request Broker Architecture
CPU	Central Processing Unit
CSS	Cascading Style Sheet
DOS	Disc Operating System
DSN	Data Source Name
EC	Electronic Commerce
ECC	Error Correction Code
EDI	Electronic Data Interchange
EIC	Enterprise Integration Technologies
FAQ	Frequently Asked Question
GNOME	GNU Network Object Model Environment
GUI	Graphical User Interface
HTML	Hyper Text Markup Language
HTTP	Hyper Text Transfer Protocol
IDE	Integrated Development Environment
IIS	Internet Information Server

LIST OF ABBREVIATIONS

I/O	Input and Output
KDE	'K' Desktop Environment
MDC	Manipulation Detection Code
MEPS	Malaysian Electronic Payment System
MIC	Message Integrity Check
MMC	Microsoft Management Console
NNTP	Network News Transfer Protocol
NTFS	New Technology File System
ODBC	Open Database Connectivity
PKI	Public Key Infrastructure
POP3	Post Office Protocol 3
RA	Registration Authority
RAD	Rapid Application Development
RSA	Rivest, Shamir and Adelman cryptosystem
SET	Secure Electronic Transaction
SHA	Secure Hash Algorithm
S-HTTP	Secure Hyper Text Transfer Protocol
SMP	Symmetric Multi Processing
SMTP	Simple Mail Transfer Protocol
SNA	System Network Architecture
SPX/IPX	Sequenced Packet Exchange/Internetwork Packet Exchange
SOM	System Object Model
SQL	Structured Query Language
SSL	Secure Socket Layer
STT	Secure Transaction Technology
TCP/IP	Transmission Control Protocol/Internet Protocol
URL	Universal Resource Locator
WYSIWYG	What You See Is What You Get

CHAPTER ONE

INTRODUCTION

1.1 Project Introduction

Malaysia welcomes the advent of the Information Age with its promise of a new world order where information, ideas, people, goods and services move across borders in the most cost-effective and liberal ways.

Electronic Commerce (EC) has shown its potential power to revolutionize industry processes, structures and redefine the competitive landscape for businesses around the world. In Asia-Pacific, it can offer exciting opportunities as young and dynamic countries leapfrog into the Information Age as evidenced by growing penetration of personal computer and Internet usage.

The E-Commerce project in this proposed report is a project to develop an interactive and attractive e-commerce web site for all local merchants and consumers. The aim of this project is to provide the opportunity of buying and selling computer products over the Internet for local market.

An overview of E-Commerce

E-commerce (electronic commerce or EC) is the buying and selling of goods and services on the Internet, especially the World Wide Web. In practice, this term and a new term, "e-business" is often used interchangeably. "E-business" includes not only buying and selling, but also servicing customers and collaborating with business partner. For online retail selling, the term e-tailing is sometimes used.

E-commerce can be divided into 5 segments, which are E-tailing, Electronic Data Interchange (EDI), E-mail, fax and Internet telephony, business-to-business buying and selling and the security of business transaction.

1. E-tailing or The Virtual Storefront

   E-tailing can be referred as a place for direct retail shopping, with its 24-hours availability, a global reach, the ability to interact, provide custom information and multimedia prospects. The web is rapidly becoming a multibillion-dollar source of revenue for the world's businesses. By early 1999, even businesses that have always counted on face-to-face customer interaction were planning for e-commerce web sites and how to coordinate in-store and web store retail approaches. Meanwhile, new businesses based entirely on web sales were being invented daily.

2. Electronic Data Interchange (EDI)

   Electronic Data Interchange (EDI) is a standard format for exchanging business data. The standard is ANSI X12 and it was developed by the Data Interchange Standards Association. An EDI message contains a string of data elements, each of which represents a singular fact such as a price, product model number and so forth separated by delimiters. The entire string is called a data segment. One or more data segments framed by a header and trailer form a transaction set, which is the EDI unit of transmission (equivalent to a message). A transaction set often consists of what would usually be contained in a typical business document or form. The parties who exchange EDI transmissions are referred to as trading partners. EDI messages can be encrypted and decrypted.

3. E-Mail, fax, and Internet telephony

   E-commerce is also conducted through the more limited electronic forms of communication called e-mail, facsimile or fax and the emerging use of telephone calls over the Internet. Most of this is business-to-business with some companies attempting to use e-mail and fax for unsolicited advertisements (usually viewed as online junk mail) to consumers and other business prospects. There are an increasing number of business web sites offer e-mail newsletters for subscribers. Another trend is the web users voluntarily sign up to receive e-mail, usually sponsored or containing advertisements about product categories or other subjects they are interested in.

4. Business-to-business buying and selling

   Business-to-business (B2B) buying and selling is also known as e-biz and it is the exchange of products, services or information between businesses rather than between businesses and consumers. Although early interest centered on the growth of retailing on the Internet (sometimes called e-tailing), forecasts are that B2B revenue will far exceed business-to-consumers (B2C) revenue in the near future. There are thousands of companies that sell products to other companies have discovered that the web provides not only a 24-hour-a-day showcase for their products but also a quick way to reach the right people in a company for more information.

5. The Security of business transactions

   The security of business transactions includes authenticating business transactions, controlling access to resources such as web pages for registered or selected users, encrypting communications and in general ensuring the privacy and effectiveness of transactions. Common security technologies used are Secure Socket Layer (SSL) and Secure Electronic Transactions (SET). The SSL protocol is used to secure the transmission of data in a network while the SET protocol is used for data encryption.

The evolution of E-Commerce

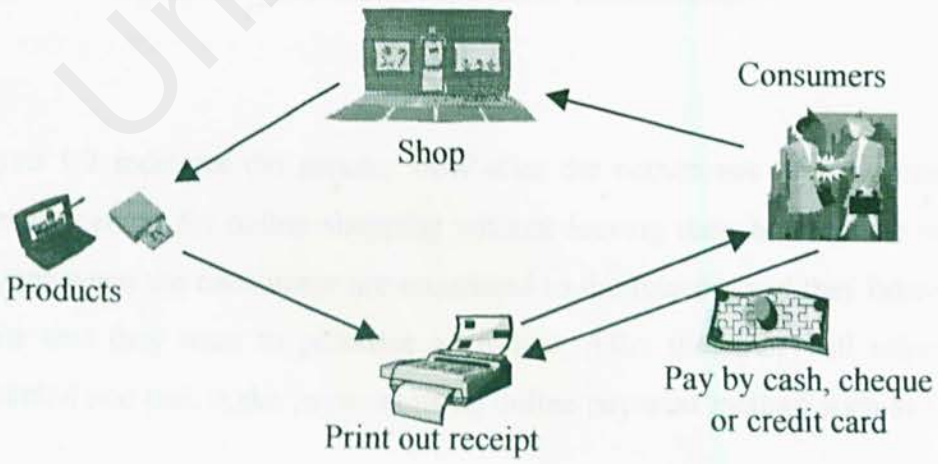

Figure 1.1 The Process Flow Before E-Commerce

Figure 1.1 indicates the process flow before the occurrence of E-Commerce. Whenever consumers want to buy any kind of products, they have to go to the shop to obtain the product by themselves. After selecting the products, the consumers will have to queue before they can pay either by cash, cheque or credit card. Then the cashier will print out a receipt for the consumers. There are a few disadvantages about this business process such as the consumers have to queue before they make any payment, the whole process require a lot of time and consumers have to travel a long distance before they can buy any products.

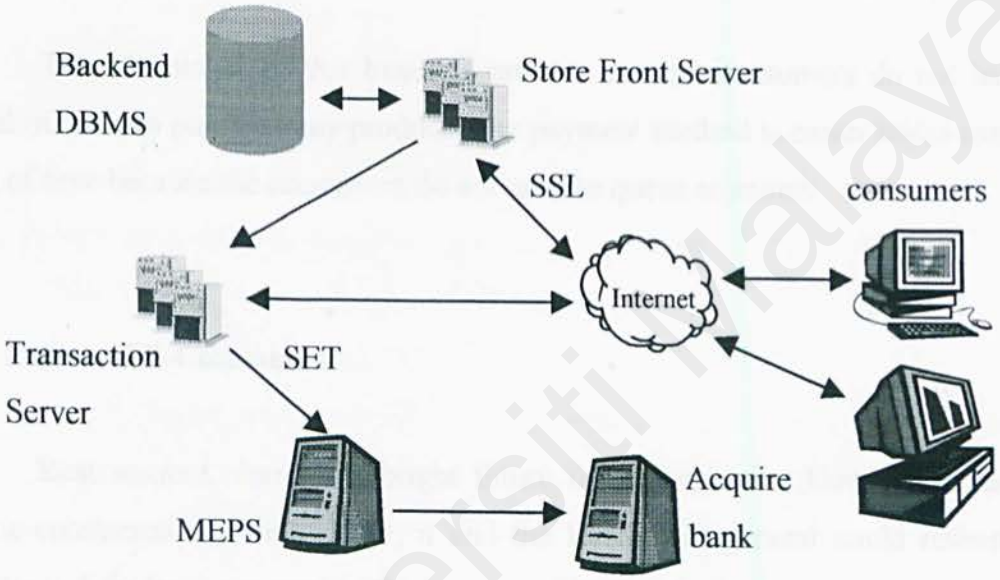

Figure 1.2 The Process Flow After E-Commerce

Figure 1.2 indicates the process flow after the occurrence of E-Commerce. The consumers can go for online shopping without leaving their homes. The whole process begins when the consumers are connected to the Internet and they browse to the web site that they want to purchase a product. After that they will select the products wanted and then make payment using online payment method such as credit card.

The Store Front Server (which is the host server for merchant) will use the Secure Socket Layer (SSL) protocol which is a program layer created by Netscape for managing the security of message transmissions in a network for the consumers to input their personal information. After that, the consumers have to input their credit card information into the Transaction Server, which will use the Secure Electronic Transaction (SET) protocol to encrypt the credit card information so that only bank can read it. Then the encrypted information will send to MEPS (Malaysian Electronic Payment System) Payment Gateway. After that, MEPS will transfer the information to the acquire bank (the merchant's bank) for verification.

The advantages of this business process are that consumers do not have to travel in order to purchase any products, the payment method is easier and it can save a lot of time because the consumers do not need to queue anymore.

The Future of E-Commerce

Rest assured, there is a bright future for e-commerce. Once the details of online commerce are worked out, it and the Internet in general could reshape the structure of the business world. The huge growth of virtual communities (people with the same interest getting together in groups online) will promise to shift the balance of economic power from the manufacturer to the consumer. These virtual communities are already making their presence felt.

Virtual communities erode the marketing and sales advantages of large companies. A small company with a better product and better customer service can use these communities to challenge larger competitors which something it probably could not do in the real world.

1.2 Project Objectives

The objectives of developing this project are as follows :

1. To build a reliable payment and security system

   The payment system in this project will use the Secure Electronic Transaction (SET) protocol, which is the most widely used technology in e-commerce to encrypt the payment information. The security system will involve the firewall to prevent unauthorized user from accessing the resources or server.

2. To provide smooth and secure transaction

   This project will the Secure Socket Layer (SSL) protocol to secure the transmission of data between the client and the server. This protocol will combine with SET protocol in order to provide a smooth and secure transaction

3. To ensure easy payment procedure

   An easy payment procedure will be implemented so that user can make payment with some easy steps. Apart from that, online help will be provided to give guidance to the user.

4. To ensure data integrity during any transaction

   The payment information will be encrypted using the combination of public key cryptography, digital certificate and digital signature. This will ensure the data integrity during any transaction.

5. To provide friendly user interface

   This project will provide a friendly user interface in order to enhance the interest of the users in online shopping or making payment over the Internet.

1.3 Project Scope

The scopes of this project are as follows :

1. The system is develop for all local merchants and consumers only.

2. Consumers must possess a credit card.

3. All online transaction will involve Malaysian Electronic Payment System (MEPS) Payment Gateway and acquisition from the bank. (Depending on the approval from the bank; a letter have been sent to the bank)

4. The security aspect will include firewall, digital certificate, digital signature and encryption. The Store Front server (the host server) will use the Secure Socket Layer (SSL) protocol to secure the transmission of data between the server and the consumer's computer.

5. The Transaction server will use the Secure Electronic Transaction (SET) protocol for encryption and payment processing.

6. Consumers must possess at least 2 components required for a SET transaction :
   - An E-Wallet, which is a web browser companion software that distributed by the bank to store and manage credit card information.
   - A Digital Certificate
     (Depending the approval from the bank; a letter have been sent to the bank)

1.4 Definitions

Acquire bank

A bank that does business with merchants who wishes to accept credit cards. Merchants are given an account to deposit the value of a batch's card sales. The bank acquires batches of sales slips and credits their value to the merchant's account.

ActiveX

An architecture of program elements developed by Microsoft. It provides a means by which independent programs can interface with one another dynamically.

AppleTalk

AppleTalk is a set of local area network communication protocol originally created for Apple computers. An AppleTalk can support up to 32 devices and data can be exchanged at a speed of 230.4 kilobits per second (Kbps).

Browser

A program that accesses and displays files available on the World Wide Web.

Certificate Authority

Trusted party that operates on the behalf of SET Corporation and payment card brands to manage the distribution and currency of SET digital certificates.

Cryptography

The science or art of designing, building and using cryptosystems.

Cryptosystem

Refers to both the algorithm used in cryptography and the means in which the algorithm is implemented.

CSS

Cascading Style Sheet. An extension to HTML to allow styles such as colour, font, and size to be specified for certain elements of a hypertext document.

Digital certificate

The binding of an entity's identity with a public key, performed by a trusted party.

Digital signature

Created using public key cryptography and message digest. When a message digest is computed and then encrypted using the sender's private key, and later appended to the encrypted message, the result is called the digital signature of the message.

Electronic commerce (E-Commerce)

Electronic forms of communication that permit the exchange of sale information related to goods and services purchasing between buyers and sellers.

Electronic wallet (E-wallet)

The credit card holder's component for SET that implements the protocol necessary from his end and helps to acquire and manage the credit card holder's digital certificate.

Encryption

The hiding or masking of information through cryptography such that only those permitted can see through the disguise.

GNU Network Object Model Environment (GNOME)

GNOME (pronounced as gah-NOHM) is graphical user interface and set of computer desktop application for LINUX operating systems.

Hash

A mechanism to reduce a large domain of possible values to a smaller range of values. Hash values and message digest are created using hashing functions.

HTML

Hyper Text Markup Language. A standardized system of tagging text for formatting, locating images and other nontext files, and placing links or references to other documents.

HTTP

Hypertext Transfer Protocol. A standardized means of using TCP/IP for communicating HTML documents over networks.

Internet

A worldwide, public network of computers that communicate using TCP/IP.

Merchant

Any business operation that accepts payment cards for goods or services. Merchants establish the privilege of accepting payment cards through relationships with the acquire bank.

Message digest

A unique fingerprint of a message that is calculated based on the contents of the message using a hashing algorithm. The original message cannot be recovered from the message digest, but is used to verify that no changes to the message took place while sending it to the recipient.

NetWare

NetWare is the network server operating system developed by Novell.

Network News Transfer Protocol (NNTP)

NNTP is the predominant protocol used by computers for managing the notes posted on Usenet Newsgroup.

Post Office Protocol 3 (POP3)

POP3 is the most recent version of a standard protocol for receiving E-mail. POP3 is a client-server protocol in which E-mail is received and held in the mail server. Periodically, the user can check their mailbox on the server and download any new mails.

Private key

The half of a key-pair that is retained on the computer which generated the key-pair. Private keys are used to encrypt messages that can be verified as legitimate if the associated public key is able to decrypt them.

Public key

The half of a key-pair that is shared with message recipients to use in sending encrypted messages back to the private key holder.

Secure Electronic Transaction (SET)

Secure Electronic Transaction (SET) is a high level protocol for ensuring the security of financial transactions on the Internet. It was supported initially by MasterCard, Visa, Microsoft, Netscape, and others.

Secure Hash Algorithm (SHA)

An algorithm used for hashing all data under the SET protocol. It is defined by Federal Information Processing Standards 180-1.

Secure Hyper Text Transfer Protocol (S-HTTP)

An extension to the HTTP protocol to support sending data securely over the web. It was developed by Enterprise Integration Technologies (EIT) in 1995.

Secure Socket Layer (SSL)

A security protocol that sits on top of a reliable transport protocol to encapsulate other higher level protocols.

Secure Transaction Technology (STT)

A predecessor payment protocol to SET which developed by Visa and MasterCard.

Simple Mail Transfer Protocol (SMTP)

SMTP is a TCP/IP protocol used in sending and receiving E-mail. However since it is limited in its ability to queue messages at the receiving end, it is usually used with another protocol, POP3 (Post Office Protocol 3) that let the user save messages in a server mailbox and download them periodically from the server.

Structured Query Language (SQL)

SQL is a standard interactive and programming language for getting information from and updating a database.

Systems Network Architecture (SNA)

SNA is a propriety IBM architecture and set of implementing products for network computing within an enterprise.

Transmission Control Protocol / Internet Protocol (TCP/IP)

TCP/IP is the basic communication language or protocol of the Internet. It can also be used as a communication protocol in the private network called Intranet.

Unicode

Unicode is an entirely new idea in setting up binary codes for text or script characters. Currently the Unicode standard contains 34,168 distinct coded characters derived from 24 supported language scripts

URL

Universal Resource Locator. The address of the file on the Internet.

WYSIWYG

A term used with form and report generators, in which the DBMS recreates exactly what the developer types on the screen while developing forms and reports.

1.5 Summary

This chapter focuses mainly on the introduction of this project. The first part is the brief introduction about this project and the overview of e-commerce. It contains the definition of e-commerce and the components of e-commerce. Besides that, the evolution of e-commerce is also discussed. It covers the process flow before the occurrence of e-commerce until the process flow after the occurrence of e-commerce. The future of e-commerce is also discussed.

After some discussion on e-commerce, then the objectives of this project are described. This project will achieve 5 main objectives, which are to build a reliable payment and security system, to ensure smooth and secure payment, to provide easy payment, to ensure data integrity during any transaction and to provide friendly user interface.

Apart from that, the scope of this project is also described. The scope of a project can be defined as the boundaries or limitations of a project. As for this project, the scope includes the parties involve, the security aspect of the online payment, the protocol used in the transaction and the conditions needed for this project.

There are many special terms or definitions that being used in this project. Each term or definition will depict a special meaning in the context of this project. A list of the special terms or definitions is enclosed in this chapter for further understanding and reference.

CHAPTER TWO

LITERATURE REVIEW

2.1 Purpose

Review of literature is a background study about the knowledge and information gained to develop this project. The purpose of this review of literature is to get a better understanding on the development tools that can be used to develop a project and also get a better knowledge on the development methodologies used while developing a project.

Apart from that, the review of literature also enables the developer to do comparison on the past-developed projects and study the strength and weakness of it. It will also give an overview of how to improve the weakness and fulfill the requirements needed.

2.2 Approach

A system is a regularly interacting or independent group of elements forming a unified whole. Thus, a system is a collection of related parts treated as a unit where its components interact . Therefore, different systems can be developed in different ways. To develop a system, a lot of information need to be gathered about the system itself, the procedures involved to develop the system and the methodologies used develop the system. All this information can be obtained from various sources [Silver et al, 1989].

Basically, each source will yield different information and facts and it depends on how the search is being done. For example, if Internet is being used to find an information, each keyword or phase that is being searched will yield various site which is totally different from one site to another. Information can be obtained from system users, computer programs, procedure manuals and report, forms and documents.

As for this project, many books and few previously done projects were used as a guide and to gain information as well as a better idea of how to develop the system. Furthermore, interview with a few staffs as well as the manager of Erasoft Systems Sdn. Bhd. were done to gain information on how to develop an E-Commerce web site. Another way of gathering information is through observation of user activities and behaviours.

Besides that, the Internet was surfed and information was gathered from various sites on software to be used to develop the project, methodologies for system development and information on development tools. The search engines that were used to gather all this information include Yahoo search, Altavista search, MSN search, Excite search and other search engines.

2.3 Findings

All the information gathered for this project came from two resources, which are the printed resources and electronic resources. Printed resources are inclusive of books, magazines, newspaper, brochures and journals while the electronic resources includes sites which are found using search engines on the Internet. Below are all the findings in detail :

2.3.1 Development Models

i) Waterfall Model

One of the first models to be proposed is the waterfall model where the stages are depicted as cascading from one to another. One development stage will be completed before the next begins. Thus, when all the requirements are elicited from the customer, analyzed for completeness and consistency, and

documented in a requirements document, then the development team can go on to system design activities [Pfleeger, 1998] .

The waterfall model can be very useful in helping developers lay out what they need to do. Its simplicity makes it easy to explain to customers who are not familiar with software development; it makes explicit which intermediate products are necessary in order to begin the next stage of development. The advantages and disadvantages of the waterfall model are as follow [Pfleeger, 1998; Visser, 1999; Methodology, 1999] :

Advantages :

1. Very structured (logical flow)
2. Predictable
3. Involves user participation (gathering requirements)
4. Good visibility
5. Inexpensive
6. Easy to manage
7. Encouraged reviews at each stage
8. Gave greater control over the project by dividing it into stages and sub-stages

Disadvantages :

1. Requirements must be well defined first
2. User must wait until the end in order to see the developed product
3. Each individual stage must be completed before moving on
4. Product failure signals process failure
5. Increases in cost-to-fix or change software occur throughout the life cycle process

ii) Prototyping Model

A prototype is a partially developed product that enables customer and developers to examine some aspect of proposed system and decide if it is suitable or appropriate for the finished product. In other words, prototyping means building a small version of a system, usually with limited functionality that can be used to help the user or customer identify the key requirements of a system and demonstrate of a design or approach [Pfleeger, 1998].

Prototyping is often used to design a good user interface: the part of the system with which the user interacts. Since the prototyping model allows all or part of a system to be constructed quickly to understand or clarify issues, it has the same objectives as engineering prototype, where requirements or design require repeated investigation to ensure that the developer, user and the customer have a common understanding both of what is needed and what is proposed. One or more of the loops for prototyping requirements, design or the system may be eliminated, depending on the goals of the prototyping. However, the overall goal remains the same that is reducing risk and uncertainty in development. The advantages and disadvantages of the prototyping model are as follow [Pfleeger, 1998; Drori, 1996] :

Advantages :

1. Allow errors to be detected early
2. More opportunity for changes
3. User orientation (to develop system that meet user needs to a greater extend)
4. Fast development time
5. Reduces development cost

Disadvantages :

1. Object system may be less efficient
2. System planning is not always complete

3. Visible use of computer resources
4. Requires cooperation between user and Information System
5. The development process of advanced versions does not always exploit the investment made in the earlier stages

2.3.2 Server Platforms

1. Microsoft Windows NT

Microsoft Windows NT is the server operating system made by Microsoft Corporation that run on Intel Pentium, Intel 80x86, Motorola/IBM PowerPC and DEC Alpha. The Windows NT operating system has a number of really interesting technical features and its history is entertaining. Unlike earlier operating systems, which merely provided a basic framework to enable you to execute applications, the Windows NT environment is rich with services that are provided by the operating system. This frees developers from having to write basic functionality and instead concentrate on the particular functions that are unique to their applications.

This rich operating system functionality also helps to promote standardization. One of the key problems with DOS, Windows 95 and Windows 98 was that every application developer made up its own rules for how they were going to implement functions such as memory management. They often conflicted with one another and this led to all sorts of integration problems. With Windows NT, most of these problems have gone away. The following are the features and services that provided by Windows NT that are most important to general users and administrators [Milo, 2000a] :

- File System Management
  Windows NT includes a new file system called New Technology File System (NTFS). This file system includes several enhancements over

existing file systems currently in use today on most network file servers. The file system is entirely transaction-based. Much like the transaction log that SQL Servers uses to maintain data integrity, the NTFS file system uses a transaction log to maintain file system integrity. NTFS also has several other beneficial features such as it includes the capability to assign access control entries (ACE) to an access control list (ACL). The ACE contains a group identifier or a user identifier encapsulated in a security descriptor, which can be used to limit access to a particular directory or file. An ACL is the container that encapsulates one or more ACE entries. Besides that it also support long filenames that exceed the normal MS-DOS 8.3 limitation. The supported long filenames can contain up to 255 characters, can be any mix of uppercase or lowercase and can include Unicode characters if desired. NTFS also includes compression support.

- Fault tolerant

  Windows NT provides the means to protect the data and keep the server running. It does this by detecting various software and hardware failures. If a failure is detected, the redundant hardware is used to continue to provide access to the network. Windows NT provides three options that can be used separately or with each other to safeguard the important data. The first method is disk mirroring by making a duplicate copy of the data in the primary partition to the secondary partition. If a device failure is detected while accessing data on the primary partition, then it can switch automatically to the secondary partition. The second method is disk duplexing by using two separate disk controllers with separate disk subsystems. If the user fail to access data on the primary partition, then access to the data can be maintained by using the redundant copy on the secondary controller and disk subsystem. The third method is disk stripping with parity. This option works by combining equally sized disk partitions on separate physical drives to create one logical partition. When data is written to the disk, an error correction code (ECC) block is written

as well. In the case of a disk failure, the data blocks can be combined with the ECC block to rebuild the missing data block.

- Scaleable

  Scaleable refers to the capability of Windows NT to execute on different hardware platforms, such as the NEC MIPS processor, the DEC Alpha processor and the IBM/Motorola PowerPC processor. Each of these different platforms can provide additional levels of performance.

- Secure

  The good news about this particular feature is that Windows NT does provide reliable method to limit access to any computer resources. This includes not only access to the server and data, but also access from one application to another application. The first aspect is related to limiting access to the network file server's shared resources and the server itself. This is accomplished through user identifications (a user ID) and password or local and group identifiers. The second aspect is related to keeping the data secure from unauthorized access.

- Symmetric multiprocessing (SMP)

  Windows NT's internal design uses a symmetric processing model that simply means that all processors can access system resources and that any process or thread can execute on any processor. This is quite different from an asynchronous multiprocessing (AMP) model, in which one processor is responsible for the operating system functionality and another processor is responsible for executing applications. With Windows NT, any process can execute on any processor, providing the capability to make more efficient use of available processor resources.

- Multithreading

  A thread is the minimum executable resource in Windows NT. The different between a thread and a process is that a process is the container

for an address space, whereas a thread executes within that address space. A process itself is not executable; it is the thread that is scheduled and executed. A single process can have more than one thread of execution while a multithreaded application can have one thread for user input (keyboard or mouse), another for printing and another for file access. When the user print a file or even save a file, these thread run in the background and the user thread run in the foreground.

2. LINUX

Linux is a free operating system that runs on Intel Pentium, Intel 80x86, Motorola/IBM PowerPC, Motorola 680x0, Sun SPARC, SGI MIPS, DEC Alpha, HP PA-RISC, DEC VAX, ARM, API 1000+ and CL-PS7110. It is also one of the popular low and medium scale server systems. Linux have several strengths [Milo, 2000b; Ganesh, 2000] :

- Stability

  Linux rarely crash because it does not required to do as much as other operating systems. Linux's design shows aspects of the most modern operating systems concepts and the most time-tested ones. Most significantly, the open-source code model of Linux seems to ensure that bugs are detected and fixed early.

- Configurability

  Another feature of Linux is that users can easily modify the configuration files to suit their requirements. There are two aspects to this. One is that unlike with most commercial software, which is distributed only in binary form, the Linux source code is readily available, making it physically possible to modify and recompile it. The other is that the GNU General Public License expressly permits anyone to modify and redistribute the software, making this legally possible as well.

- Virus proof design

  Linux have two clearly demarcated privilege levels, which are user and system. A normal user or a program owned by a normal user has no privilege to delete system files or files belonging to other users because such actions require system privileges. The administrator of a Linux system is the only one with system privileges. Therefore normal users of Linux have limited ability to cause damage to their systems by importing suspect files from elsewhere.

- Interoperability with existing systems

  Linux is widely claimed to be able to coexist with other operating systems and even talk some proprietary protocols. Linux can talk SPX/IPX in a Netware environment, Appletalk in a Macintosh crowd and even SNA to IBM mainframes. But for most organisations, the most important and relevant aspect of Linux's claimed interoperability is its ability to coexist with Windows machines.

However Linux also have several weaknesses [Milo, 2000b; Ganesh, 2000] :

- User unfriendliness

  Most of the interface in Linux are command-line interface (CLI) that required user to type command in order for the machine to execute particular instruction. Although Linux had developed two graphical desktop environments that are KDE ('K' Desktop Environment) and GNU Network Object Model Environment (GNOME) but neither interface is as yet as polished and complete as the Windows desktop.

- Installation problem

  Even though Linux does a reasonably good job of detecting all the hardware components on a computer, it does require some enlightened input from the installer. Disk partitioning and mounting of file systems are relatively advanced concepts, especially for users who are used to the

simple drive letters of Windows. With many Linux distributions, the user also has to know the details of the graphics adapter card and monitor in order to provide the information the installation program requires.

- Lack of high-end features

  Linux is a relatively new operating system developed largely by volunteer programmers. These developers have not so far had access to high-end and expensive hardware although many vendors are now making large systems available for independent developers to work on. Besides that, Linux does not yet scale well beyond 4 Central Processing Unit (CPUs), has no support for high-availability clustering, Cache-Coherent Non-Uniform Memory Access (CCNUMA) architectures and cannot host multiple independent operating system on the same machine.

- Lack of technical support

  The only technical support one could get for Linux was in-house (if a company had a resident Linux expert) or through mailing lists. Mailing lists is a particularly pathetic way to obtain technical support because people seldom received quality suggestions and fast solutions through this medium.

3. 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 [Kirch, 1999; Holsberg et al, 1994; FreeBSD Vs Linux Vs Windows NT, 2000] :

- High reliability

  Unix is extremely robust because the new file system optimizes disk input and output (I/O) for high performance. It also ensures reliability for transaction 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 operating system because of its 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 [Kirch, 1999; Holsberg et al, 1994; FreeBSD Vs Linux Vs Windows NT, 2000] :

- Expensive

  Unix is very expensive compare 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 required 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 need the concept of disk partitioning and mounting of file systems, which are relatively an advanced concepts 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 required the users to type a set of specific commands for configuration and maintenance. The configuration is not guided with any wizard or GUI interface.

4. OS/2

OS/2 was the operating system that developed by IBM. The benefits of having OS/2 are [Advantages of OS/2 Warp 4 Over Microsoft Windows NT 4.0 Workstation, 1996; OS/2, 2000; The Best 32bit Operating System, 1996] :

- 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 ease 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 have several weaknesses [Advantages of OS/2 Warp 4 Over Microsoft Windows NT 4.0 Workstation, 1996; OS/2, 2000; The Best 32bit Operating System, 1996] :

- Limited application support
- Average reliability
- Poor usability

2.3.3 Web Servers

1. Internet Information Server (IIS)

Microsoft Internet Information Server (IIS) has the reputation for being one of the best web servers on the market. Although it is only available for Windows NT, IIS has transformed the NT platform into a viable solution for deliver web-based applications. IIS is considered by experts to be just as powerful and much easier to set up and maintain than many of its UNIX-based competitors.

The three major goals of Internet Information Server are that it is focused on the server side of the Internet world, to have the capability of

supporting an intranet as well as the Internet and to form the basis that will enable future product development. Internet Information Server provides three basic services to users, which are World Wide Web server, File Transfer Protocol server and Gopher server. Some of its features are [Detailed Information About Internet Information Server 4.0, 2000] :

- Free download
  It is available for free download.

- Superior administration control
  Site administration for IIS is performed using the Microsoft Management Console (MMC). Via this interface the users can manage access and security restrictions at the site, directory and file level. If the users are using virtual sites, then they can specify the estimated daily traffic for each site (which controls how much memory IIS allocates for each web site) and limit the amount of server bandwidth a particular site can use. Most settings can also be configured remotely using Microsoft Internet Explorer. Active Server Pages (ASP) improvements in the latest release of IIS include additional support for transaction processing and memory isolation.

- Excellent collection of server tools
  It offers a variety of tools including a Transaction Server (for building distributed applications, Certificate Server (managing digital certificates), Site Analyst (site management and usage), Internet Connection Services for Microsoft Remote Access Service (creation of Virtual Private Networks), Mail Server and Network News Transfer Protocol (NNTP) News Server.

- Indexing tool also handles Microsoft Office documents

  It also includes an indexing tool called Index Server. The Index Server is use for indexing HTML pages and can also handles Microsoft Office documents.

- Integrated search engine

  Internet Information Server provide the integrated search engine capabilities, which the users can create custom search forms with Active Server pages, ActiveX Data Objects and SQL queries.

The weaknesses of Internet Information Server (IIS) are as follows [Detailed Information About Internet Information Server 4.0, 2000] :

- Lack of support for UNIX platform.
- Only runs on Server edition of Windows NT
- Complicated to configure
- SMTP does not support POP mailboxes
- Mediocre documentation

2. Apache Web Server

Apache Web Server is among one of the popular web server on the market today. Some of its strengths are its reliability, performance and rich set of features. In large part, its popularity is due to the fact that its code is freely distributed. Among its features are [Detailed Information About Apache 1.3.12, 2000] :

- Freeware

  The software can be downloaded free of charge.

- Multiple platforms support

  Apache can support a variety of platforms such as Windows 9x, Windows NT, Linux, O/S 2, Novell Netware, Macintosh and others.

- Logging

  Apache can write to multiple log files and these log files can be automatically cycled or archived. The server also can generate referer log entries and non-hit entries (such as comment). It can track individual users in log file.

- Protocol Support

  Apache can support the Windows Common Gateway Interface (CGI), HTTP/1.1 protocol. User can access the server state variables through CGI or scripting languages.

Despite all its strengths, Apache also has some weaknesses. These include [Detailed Information About Apache 1.3.12, 2000] :

- Setup and maintenance of the server is done via command-line scripting tools. Apache does not offer browser-based maintenance facility.

- It does not have any Graphical User Interface (GUI) configuration or administration tools.

- The security is low and it does not support secure communication using Secure Socket Layer (SSL).

- More extensive technical support requires the purchase of third-party support contract.

3. Netscape Enterprise Server

The Netscape Enterprise Server is a high-performance, enterprise-strength web server. The latest version provides support for the HTTP 1.1 protocol, a built-in search engine with document 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. There are a few benefits of the Netscape Enterprise Server, which include [Detailed Information About Netscape Enterprise Server 3.5.1, 2000] :

- Widespread platform support
  The Netscape Enterprise Server can support a variety of platforms such as Windows NT, UNIX, IRIX, AIX, HPUX and others.

- End-user publishing capabilities
  "Netshare" is an innovative approach which gives end users the ability to manage their own content. Services include web publishing, access, version control, agent services and link management. Netshare 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.

- Integrated search engine
  It also includes an integrated search engine as one of its features.

- Centralized server management
  The Netscape Enterprise Server's centralized server management feature is very useful for large organizations with many users and multiple web servers. It also includes Netscape Directory Server 3.0 for directory support.

The weaknesses of Netscape Enterprise Server are as follows [Detailed Information About Netscape Enterprise Server 3.5.1, 2000] :

- Complexity
  It is very difficult to configure the server because lack of GUI-based interface.

- Lack of technical support
  The only way of getting technical support is through mailing lists. Mailing lists is a particularly pathetic way to obtain technical support because people seldom received quality suggestions and fast solutions through this medium.

- Expensive
  The price is very expensive compare to other web server such as Microsoft Internet Information Server (IIS) and Lotus Domino Go Web Server.

4. Lotus Domino Go Web Server

The Lotus Domino Go Web Server is developed by Lotus Development Corporation. It has several strengths such as [Seachrist et al, 1997] :

- Multiple platforms support
  It has a widespread platforms support.

- High performance
  Lotus Domino Go Web Server uses the rich Lotus Notes content data store, provides middleware services to handle file-format incompatibilities, offers an upgrade path to fault tolerance and load balancing. This rich features base makes it to produce high performance.

- Provide Workgroup Services
  Workgroup services include directory, group scheduling, document library, work flow, forum and news that aid collaboration among a company's employees.

Despite its strengths, Lotus Domino Go Web Server also has some weaknesses [Seachrist et al, 1997] :

- Lack of technical support
- Does not support distributed object technology
- Does not support Java virtual machine

2.3.4 Programming Languages

1. Active Server Pages (ASP)

Active Server Pages (ASP) is a Microsoft-developed technology for building dynamic web content. ASP communicates between clients and web servers via the HTTP protocol of the World Wide Web. When client sends an HTTP request to the server, the server receives the request and directs it to be processed by appropriate Active Server Pages. The Active Server Pages does its processing (including interacting with the database) then returns its result to the client. It is normally in the form of a HTML document to display in the browser. It can be other format such as images and binary data [Cluts, 1998; Active Server Pages, 1999].

There are several programming languages that can be used to program ASP, but VBScript and JavaScript are often used. Normally, ASP will differentiate between client-side scripting and server-side scripting. Client-side scripting is browser dependent so browser or scripting host must support the scripting language that used. Server-side scripting resides the server and thus

programmers have greater flexibility especially with the database access [Cluts, 1998; Active Server Pages, 1999].

ASP includes the several modern technologies. The details for each technologies are as follows [Cluts, 1998; Active Server Pages, 1999] :

- Advanced Data Connector (ADC)

  It provides client-side database access. This means that the entire set of database data (such as query results) is send to the browser, which the user can then continue to manipulate. This will reduces the amount of traffic on the network connection and also the load on the server. A simple example of a client-side database task is sorting a set of data with some criteria. If the results of the query are already in the web browser, it seems wasteful to contact the server to re-sort the results by phone number instead of last name when all of that information is already in the browser.

- ActiveX Database Objects (ADO)

  It is the server-side components that dynamically connect data in a database to web pages. These objects can be used to both client and server information for building dynamic content web pages. The server takes the database data (such as a query) and integrates it into a web page template, which produces a custom-generated HTML page. This page will be display in the client's browser.

- VBScript

  The glue that binds ADO and ADC into the Active Server Pages model is VBScript. This web scripting language is subset of Microsoft Visual Basic programming language. It applies Event-driven technique that makes it easy to learn and implement in the project. VBScript is comparable to server-side JavaScript implementations like Netscape LiveWire. Unfortunately, some browser such as Netscape does not support VBScript unless installing some kind of plugins.

2. PERL

Perl was written by Larry Wall in 1986 with the helps from many other contributors. It is an interpreted language optimized for scanning arbitrary text files, extracting information from these files and printing reports based on that information. It is also a good language for many system management tasks. The language is intended to be practical-easy to use, efficient, elegant and minimal.

Perl has many advantages as a general-purpose scripting language. These benefits include [Breedlove et al, 1996] :

- Availability
  Perl is readily available from many sources including any Unix archive. It is also easy to obtain the source code or precompiled binaries for many platforms. Perl is often distributed with CD collections of utilities for UNIX platforms.

- Efficient
  Perl is a straight-line language, which means that simple programs do not have to deal with complex formatting or function/procedure or object/method structures to accomplish their task.

- Has built-in debugging facilities
  The Perl interpreter has a built-in debugger that can help reduce the time it takes to debug applications. The debugger is activated through the use of the -d switch on the command line. In addition, the -w switch provides a complete set of warnings that can be invaluable in debugging Perl scripts.

However Perl also has a few disadvantages as a scripting language for system administration task and as a language for module development. Below are the details of disadvantages [Breedlove et al, 1996] :

- Poor maintainability of scripts
  Perl has somewhat of a reputation for being unreadable and this can be a problem for system maintenance. However, Perl is probably no more unreadable than any C-like language. The maintainability of Perl relies heavily on the willingness of the programmer to structure and document the code.

- Lack of support
  The support for Perl is on an informal basis through the volunteer efforts of users worldwide.

- Interpreted Language
  Perl is an interpreted language and therefore it will not be as fast as compiled languages such as C or C++.

3. Java Servlet

Java Servlet technology provides web developers with a simple, consistent mechanism for extending the functionality of a web server and for accessing existing business systems. A servlet is a small program that runs on a server. The term was coined in the context of the Java applets, a small program that is sent as a separate file along with a web page. Java applets usually intended for running on a client can result in such services as performing a calculation for a user or positioning an image based on user interaction [Java Servlet Technology, 2000].

Some programs such as those access databases based on user input need to be on the server. Typically, these have been implemented using a Common Gateway Interface (CGI) application. However, with a Java running in the server such programs can be implemented with the Java programming language. The major advantage of a Java servlet on servers with lots of traffic

is that they can execute more quickly than CGI applications. Rather than causing a separate program process to be created, each user request is invoked as a thread in a single daemon process, meaning that the amount of system overhead for each request is slight [Java Servlet Technology, 2000].

Instead of a URL that designates the name of a CGI application (in a "cgi-bin" subdirectory), a request in a form on a web HTML page that results in a Java servlet getting called would call a URL that looks like this: http://www.whatis.com:8080/servlet/gotoUrl?http://www.someplace.com. The "8080" port number in the URL means the request is intended directly for the web server itself. The servlet would indicate to the web server that a servlet was being requested. Add-on modules allow Java servlets to run in Netscape Enterprise, Microsoft Internet Information Server and Apache servers [Java Servlet Technology, 2000].

2.3.5 Development tools

1. Microsoft Visual Interdev 6.0

Visual Interdev is a comprehensive, web-based application development tool. It provides an integrated environment that brings together various technologies to work toward a common goal of building robust and dynamic applications for the web. It achieves this integrated development environment through the use of its Microsoft Development Environment, also employed by Visual J++. User can open and work on Visual J++ projects while simultaneously creating Visual Interdev project. This feature greatly enhances productivity, especially when building components using the Microsoft Component Object Model (COM) and incorporating these objects into the Visual Intedev application. It can also open multiple Visual Interdev projects within the same workspace [Hoozer, 1998].

Visual Interdev enables the developer to build applications that are dynamic and interactive. Visual Interdev enables the developer to build dynamic web pages through the use of client and server side scripting. By default, Visual Interdev supports the use of VBScript and JScript. Scripting languages such PerlScript, can be used for project development given that the appropriate scripting engine for the language is available [Hoozer, 1998].

Database integration is vital to any application. Visual Interdev provides a rich and robust set of visual database tools to immediately enhance your productivity. Visual Interdev supports the major ODBC-complaint database, both on the desktop and the server [Hoozer, 1998].

Furthermore, managing the web site once it has been developed is a very crucial function. Visual Interdev provides a set of tools to view and maintain the site. These tools are similar and compatible with the site management tools found in Microsoft FrontPage [Hoozer, 1998].

Visual Interdev supports the major object-based technologies that exist for developing web-based application, including ActiveX controls and Java applets. Transformation of script code into "object-based" functions such as scriplets and using them within the Visual Interdev project can be done. Visual Interdev supports the use of third party ActiveX controls and enables the user to integrate custom ActiveX controls. Visual Interdev also provides design-time controls that enables the user to visually set control properties when user designs the application and then use this functionality at runtime without the overhead of typical ActiveX control [Hoozer, 1998].

Furthermore, Visual Interdev 6 enables single developer to work and test parts of a project against local web server without interfering with the team, then synchronize and deploy changes to the shared Master Web Server.

It adds database connections to a web site without any programming, including visually setting connection properties such as cursor drivers, query time-outs, etc. It also drag and drop from the Data Environment to quickly create sophisticated data-driven HTML forms. Query Builder allows developers to visually construct complex SQL statements against any ODBC database.

2. Microsoft FrontPage 2000

Microsoft FrontPage 2000 is designed to be an all-purpose web site authoring package, so database integration is an essential feature. Its web database design capabilities are more sophisticated than the simple wizards available in the Access database package but are not as robust or well integrated as the Microsoft Visual InterDev development environment.

The database tool is adequate for creating dynamic web pages from database information. It's mainly designed for displaying database records in a table or similar format, though it could be used for a more sophisticated application such as dynamically generating the table of contents for an online magazine.

FrontPage 2000 have several features such as ease of learning and ease of use. The database aspect of FrontPage is not difficult to learn and there is a basic tutorial included in the software. The tutorial begins with directions for creating a specific query that returns the results to a web page dynamically. This would be useful for lists such as address books and some kinds of reports since the query is unchanging, but the data values can change. The rest of the tutorial describes how to combine an input form with a result page to dynamically query the database. Some users may be able to do basic database publishing using the Database Region Wizard without any further study. Each screen of the wizard has fairly detailed directions for setting up each

component of the web database from the ODBC connection to the SQL statements [Ashenfelter, 1998].

The database tool in FrontPage is easy to use as long as users do exactly what it tells. All of the editing, publishing and some web server settings are available from within the FrontPage interface. This makes it very easy to create great-looking pages to hold data from a database. FrontPage has also upgraded the way in which it imports HTML code. This code now remains "clean" without FrontPage embellishing it with its own custom tags [Ashenfelter, 1998].

Unfortunately, FrontPage also have some weaknesses. The first weakness is that FrontPage is essentially incompatible with any other software beside Microsoft software. It does adhere to ODBC standards and uses SQL code, but documentation for anything other than Access and SQL Server is impossible to find [Ashenfelter, 1998].

The second weakness is the slow performance of FrontPage. FrontPage tends to create web pages with a lot of extra (and often Internet Explorer-specific) HTML markup, which slows down the loading of all pages; but the way it constructs database tables adds a significant bulk to the page served to the browser. Besides that, web database applications created with FrontPage are only portable within the spectrum of Microsoft products. As long as the server is Microsoft IIS running ASP then the application can be ported. Currently Windows 9x, Windows NT Workstation and Windows NT Server are the only three operating systems that can be used with a FrontPage web [Ashenfelter, 1998].

3. Drumbeat 20000

Drumbeat 2000 was published by Elemental Software and now is part of MacroMedia. It is a WYSIWYG page editor and is site-oriented in its approach to web development. It can only run on Windows 9x or Windows NT platform and had good web-based support for probably any application.

Drumbeat's main strength which apart from being a very good web development package is its database publishing capabilities. It also specialized in connectivity to ODBC databases such as Microsoft Access and Microsoft SQL Server. Complete sites and e-commerce solutions (with an optional module) can be built in a complete drag-and-drop environment. Web pages are built using a page editor similar to Cold Fusion. For example, selecting an element such as a navigation control and linking it to the desired page to which the user wants to navigate enables navigation between the pages. Behind the interface is a very powerful package that is quite capable of building a simple five-page site or a mammoth e-commerce site. All the bells and whistles are included in Drumbeat 2000 such as button rollovers and Dynamic HTML effects [Macromedia Drumbeat, 2000].

However Drumbeat is very complex for new user to use. Its interface is a little on the quirky side and this is definitely not a product that new user can pick up without going through the tutorials. In fact, many new users will have to revisit the tutorials a few times until they understand why Drumbeat approaches some aspects of site development in the way it does. Besides that, many of the steps required to construct a web site in Drumbeat are not exactly intuitive. For example, user will have problem setting the text attributes and links because it required several steps [Macromedia Drumbeat, 2000].

2.3.6 Security Measures

Secure Socket Layer (SSL)

Secure Socket Layer (SSL) is a program layer created by Netscape for managing the security of message transmissions in a network. Netscape's idea is that the programming for keeping messages confidential ought to be contained in a program layer between an application (such as web browser) and the Internet's TCP/IP layers. The "socket" part of the term refers to the socket method of passing data back and forth between a client and a server program in a network or between program layers in the same computer. Netscape's SSL uses the public-and-private key encryption system from RSA, which also includes the use of a digital certificate.

Secure Electronic Transaction (SET)

Secure Electronic Transaction (SET) is a system for ensuring the security of financial transactions on the Internet. It was supported initially by MasterCard, Visa, Microsoft, Netscape, and others. With SET, a user is given an electronic wallet (digital certificate) and a transaction is conducted and verified using a combination of digital certificates and digital signatures among the purchaser, merchant, and the purchaser's bank in a way that ensures privacy and confidentiality. SET makes use of Netscape's Secure Socket Layer (SSL), Microsoft's Secure Transaction Technology (STT), and Terisa System's Secure Hypertext Transfer Protocol (S-HTTP). SET uses some but not all aspects of a public key infrastructure (PKI) [Secure Electronic Transaction, 1999; SET Secure Electronic Transaction at VISA, 2000].

The example below will illustrate how SET works :
Assume that a customer has a SET-enabled browser such as Netscape Navigator or Microsoft Internet Explorer and that the transaction provider (bank or store) has a SET-enabled server [Secure Electronic Transaction, 1999].

1. The customer opens a MasterCard or Visa bank account. Any issuer of a credit card is some kind of bank.
2. The customer receives a digital certificate. This electronic file functions as a credit card for online purchases or other transactions. It includes a public key with an expiration date. It has been digitally signed by the bank to ensure its validity.
3. Third-party merchants also receive certificates from the bank. These certificates include the merchant's public key and the bank's public key.
4. The customer places an order over a web page.
5. The customer's browser receives and confirms from the merchant's certificate that the merchant is valid.
6. The browser sends the order information. This message is encrypted with the merchant's public key, the payment information that encrypted with the bank's public key (which cannot be read by the merchant) and information that ensures the payment can only be used with this particular order.
7. The merchant verifies the customer by checking the digital signature on the customer's certificate. This may be done by referring the certificate to the bank or to a third-party verifier.
8. The merchant sends the order message along to the bank. This includes the bank's public key, the customer's payment information (which the merchant cannot decode) and the merchant's certificate.
9. The bank verifies the merchant and the message. The bank uses the digital signature on the certificate with the message and verifies the payment part of the message.
10. The bank digitally signs and sends authorization to the merchant, who can then fill the order.

E-Wallet

An E-Wallet is also known as electronic wallet. It is a web browser companion software that stores and manages credit card accounts on the hard disk in an encrypted form [Merkow et al, 1998].

E-Wallet address two important issues related to Secure Electronic Transaction (SET) [Merkow et al, 1998]:

1. Security

   The consumer can open his/her password-protected wallet only when the password matches. Once the consumer makes a purchase, his/her identity is validated through the use of Digital Certificate.

2. Convenience

   Consumers no longer have to fumble for credit cards and type the same information into electronic forms time and time again. Rather, they will enter payment and address information once into the wallet and start to purchase online.

Digital Certificate

A digital certificate is an electronic "credit card" that establishes the consumers' credentials when doing business or other transactions on the web. It is issued by a Certification Authority (CA) [Digital Certificate, 2000].

Digital Certificate binds a person's identity to a pair of electronic encryption keys that a person uses to encrypt or sign digital information. A digital certificate helps to verify the identity of the sender of a message and the rights to use the encryption keys. This prevents people from impersonating other people. Digital certificate used in conjunction with encryption provides a more complete security mechanism than non-encryption process [Digital Certificate, 2000].

A generic digital certificate typically contains 6 elements. The elements are as the following [Merkow et al, 1998] :

- Owner's name
- Owner's public key (used for encrypting and decrypting messages and digital signatures)

- Expiration date of the public key
- Name of the certificate issuer
- Serial number of the certificate
- Digital signature of the certificate issuer (so that a recipient can verify that the certificate is real)

Digital Signature

A digital signature (not to be confused with a digital certificate) is an electronic rather than a written signature that can be used by someone to authenticate the identity of the sender of a message or of the signer of a document. It can also be used to ensure that the original content of the message or document that has been conveyed is unchanged. Additional benefits to the use of a digital signature are that it is easily transportable, cannot be easily repudiated, cannot be imitated by someone else and can be automatically time-stamped [Digital Signature, 2000].

A digital signature can be used with any kind of message whether it is encrypted or not, simply so that the receiver can be sure of the sender's identity and that the message arrived intact. A digital certificate contains the digital signature of the certificate-issuing authority so that anyone can verify that the certificate is real. Digital signatures use public key infrastructure (PKI) technology as the foundation for providing services like authentication of sender as well as ensuring data integrity [Digital Signature, 2000].

The example below will illustrate how digital signature works :
Assume that a person A are sending an important quotation through email to someone and this has to be digitally signed by person A to assure the recipient that received message is unchanged and it is really from person A [Digital Signature, 2000].

1. Person A will copy and paste the quotation into the email.

2. This is then transformed into a message digest or a hash (mathematical summary) using a one-way hash function.
3. This hash is now encrypted using person A's private key that is obtained from a Certificate Authority.
4. This encrypted hash or message digest is now the digital signature for the message.
5. Person A will send both the original message as well as the encrypted message digest to the recipient separately. The certificate obtained from the Certificate Authority is also sent along with the encrypted message digest.
6. When the recipient received the message, he or she will make a hash of the unencrypted messages received.
7. Then the encrypted hash is decrypted using sender's public key, which can either be obtained from a key repository or from the certificate which travels along with the digitally signed document.
8. Both these hashes are then compared and if they match, then the recipient is sure that the message is sent by person A and that it has not been altered.

One-Way Hash Function

A one-way hash function has many names such as compression function, contraction function, message digest, fingerprint, cryptographic checksum, message integrity check (MIC) and manipulation detection code (MDC). Hashing is the transformation of a string of characters into a usually shorter fixed-length value or key that represents the original string [Schneier, 1996].

A one-way hash function, $H(M)$, operates on an arbitrary-length pre-image message, M. It returns a fixed-length hash value, h.

$h = \mathrm{H}(M)$, where h is of length m

Many functions can take an arbitrary-length input and return an output of fixed length, but one-way hash functions have additional characteristics that make them one-way [Schneier, 1996] :

Given M, it is easy to compute h.

Given h, it is hard to compute M such that $H(M) = h$.

Given M, it is hard to find another message, M', such that $H(M) = H(M')$.

Hashing is also used to encrypt and decrypt digital signatures (used to authenticate message senders and receivers). The digital signature is transformed with the hash function and then both the hashed value (known as a message-digest) and the signature are sent in separate transmissions to the receiver. Using the same hash function as the sender, the receiver derives a message-digest from the signature and compares it with the message-digest it also received. They should be the same [Schneier, 1996].

The hash function is public and there is no secrecy to the process. The security of a one-way hash function is its one-wayness. The output is not dependent on the input in any discernible way. If a single bit change in the pre-image changes then it will affect half of the bits in the hash value [Schneier, 1996].

There are several well-known hash functions used in cryptography. These include the message-digest hash functions MD2, MD4 and MD5 that are used for hashing digital signatures into a shorter value called a message-digest). Another hash function is the Secure Hash Algorithm (SHA) which is a standard algorithm that makes a larger (60-bit) message digest and is used in the Secure Electronic Transaction (SET) protocol [Schneier, 1996].

Public Key Infrastructure (PKI)

A public key infrastructure (PKI) enables users of a basically unsecured public network such as the Internet to securely and privately exchange data and money through the use of a public and a private cryptographic key pair that is obtained and shared through a trusted authority. The public key infrastructure provides for digital

certificates that can identify individuals or organizations and directory services that can store and revoke them when necessary [Brayton et al, 2000].

The public key infrastructure assumes the use of public key cryptography, which is the most common method on the Internet for authenticating a message sender or encrypting and decrypting a message. Traditional cryptography has usually involved the creation and sharing of a secret key for the encryption and decryption of messages. This secret or private key system has the significant flaw that if the key is discovered or intercepted by someone else, messages can easily be decrypted. For this reason, public key cryptography and the public key infrastructure is the preferred approach on the Internet. The private key system is sometimes known as symmetric cryptography and the public key system as asymmetric cryptography [Brayton et al, 2000].

A public key infrastructure consists of 4 elements. The details of each elements are as follows [Brayton et al, 2000]:

1. A certificate authority (CA) that issues and verifies digital certificates. A certificate includes the public key or information about the public key.
2. A registration authority (RA) that acts as the verifier for the certificate authority before a digital certificate is issued to a requestor.
3. One or more directories where the certificates (with their public keys) are held (usually in an ITU X.500 standard directory).
4. A certificate management system, which refers to the software that helps in issuing, validating and managing the certificates.

In public key cryptography, a public and private key are created simultaneously using the same algorithm (a popular one is known as RSA) by a certificate authority (CA). The private key is given only to the requesting party and the public key is made publicly available (as part of a digital certificate) in a directory that all parties can access. The private key is never shared with anyone or sent across the Internet. The sender uses the private key to decrypt text that has been encrypted

with the public key by someone else (who can find out what the sender's public key is from a public directory). Table 2.1 illustrates the example of how the public key cryptography works [Brayton et al, 2000] .

Task	Use Whose	Kind of key
Send an encrypted message	Use receiver's	Public key
Send an encrypted signature	Use sender's	Private key
Decrypt an encrypted message	Use receiver's	Private key
Decrypt an encrypted signature and authenticate the sender	Use sender's	Public key

Table 2.1 Public Key Cryptography

Through encryption and digital signatures, public key cryptography provides the 5 elements of network security [Schneier, 1996] :

1. Confidentiality - The public key encryption algorithm ensures that data cannot be decrypted without the appropriate private key.

2. Access Control - Only people who hold a private key that corresponds to the public key used to encrypt data can access it.

3. Authentication - The identity of the sender is confirmed by decrypting the hash with the associated public key.

4. Integrity - Confirmation that the data has not been tampered with in transmission is achieved by re-computing the hash and comparing it with the original value generated and encrypted by the sender.

5. Non-repudiation - The sender cannot deny participation in the transaction, as only the sender possesses the private key used to digitally sign the data.

Rivest, Shamir and Adelman (RSA) Cryptosystem

RSA is an Internet encryption and authentication system that uses an algorithm developed in 1977 by Ron Rivest, Adi Shamir and Leonard Adleman. The RSA algorithm is the most commonly used encryption and authentication algorithm and is included as part of the web browsers from Netscape and Microsoft. It is also part of Lotus Notes, Intuit's Quicken and many other products. The encryption system is owned by RSA Security. The company licenses the algorithm technologies and also sells development kits [Rundatz et al, 2000].

The mathematical details of the algorithm used in obtaining the public and private keys are available at the RSA web site. Briefly, the algorithm involves multiplying two large prime numbers (a prime number is a number divisible only by that number itself and 1) and through additional operations deriving a set of two numbers that constitutes the public key and another set that is the private key. Once the keys have been developed, the original prime numbers are no longer important and can be discarded. Both the public and the private keys are needed for encryption and decryption but only the owner of a private key ever needs to know it. Using the RSA system, the private key never needs to be sent across the Internet [Rundatz et al, 2000].

2.3.7 Local E-Commerce Review

1. Alfa Advanced Computer

URL : http://www.aac.com.my

This site is conducted by Alfa Advanced Computer, which is situated in skudai, Johor Bahru. The company is selling computer products for local market. There are four main options provided in this web site such as buying computer with KWSP (Kumpulan Wang Simpanan Pekerja), computer packages, Do-It-Yourself (DIY) for own customization and buying laptops.

There are several weaknesses about this local e-commerce application can be found on this site. The details are as below :

1. Unattractive interface

   Although this is an e-commerce site that sells computer products but it did not provide any picture about the particular product. The consumers cannot view any product that they want to purchase so they do not know what the product will look like. This will decreases consumers' enthusiasm to buy products from this site.

2. Lack of online payment methods

   The consumers cannot make any kind of online payment in order to purchase particular product. They cannot pay using credit card because the company does not provide any online payment service.

3. Lack of online help

   The consumers will find it hard to get online help or any other shopping guide because the company does not provide any guidelines for the consumers to seek help.

2. Taji.com Sdn. Bhd.

URL : http://www.computer.com.my

This site is maintained by Taji.com Technology Sdn. Bhd. (previously known as TAJI Enterprise). The company is selling a variety of computer accessories. The weaknesses are it does not provide any kinds of online payment service and lack of information provided. After the consumers had selected the product to purchase, they cannot pay using online payment. Instead, they have to pay cash when the product is delivered to them.

Besides that, the loading time of this e-commerce application is very slow. This will not attract the consumers to visit this web site again because the consumers

have to wait for so long in order to view a product. It also does not provide any online help or shopping guide.

3. MTEC

URL : http://mtec-comp.com

This is a simple local e-commerce owned by MTEC Computer (M) Sdn. Bhd. There are totally no graphics on the web site. In general, it can be said that this web site is dull and have no attractive to the visitor. It also provides limited functions. Functions that provided are product search, viewing product list, viewing buying baskets and registration. Online payments are not provided and if customers want to buy any product, they have to enter their personal information in a payment form provided. Customers can only make payment when the product is delivered to them.

There are some weaknesses on this e-commerce application. The details are as follows :

1. Not easy to use

   There are no online help provided and it also does not provide any methods for the consumers to send their feedback.

2. The interface is unfriendly

   The interface is not easy to use and lack of important information. For example, the search function in this e-commerce application only has a text field and a button. Consumers does not know what are the criteria that to be use to search.

3. Lack of information provided

   There are no online technical help provided. Technical supports may include providing information to help customer to setup the hardware.

4. Does not support online payment

   Consumers cannot pay via credit card because the company does not provide this service.

4. CyberComp

URL : http://plazaputra.kubsistem.com/cgi-bin/cybercomp.storefront/

It is owns by KUB Sistem Sdn. Bhd (a MSC status company). This e-commerce web site provides selling computer accessories only. Functions that provide are product search, shopping carts, price calculator, and help through email.

There are several weaknesses about this e-commerce application. The details are as below :

1. The interface is unfriendly

   Although the interface design is better than MTEC, but still need some improvements. For example, the layout in the "User guide" section is too crowded that makes it difficult for customers to read.

2. Lack of technical support

   There are no technical support provided to help the consumers.

3. No error or prompt message

   The error message does not prompt the consumers if any error occur. For example, if the consumers do not fill in the required field (such as shipping address), the error or prompt message does not pop-out to inform the consumers about the error but it just stop at that page and cannot proceed.

2.3.8 Foreign E-Commerce Review

1. Dell

URL : http://www.dell.com

This e-commerce web site is own by Dell Corporation. It sells the whole set of computer system and other computer peripherals. It is a good example of web application using Windows NT, SQL server and ASP technology. This web application provides functions that may not found in local e-commerce web application. These functions are computer package customization, many types of search, online technical support, software driver download, computer parts comparison and system compatibility check. Apart from that, consumers can also choose to pay through various types of paying method such as credit card and cheque.

Besides that, the user interface is attractive and the performance of this web site is fast. Although it does not have animations, but the rich features stated above are already enough to attract the consumers to visit this web site again.

2. Gateway

URL : http://www.gateway.com

This e-commerce web site is own by Gateway Corporation. It sells the whole set of the computer system and computer peripherals. It is a good example of e-commerce application.

This web application provides a variety of functions that may not found in local e-commerce web application. The strengths about this e-commerce are :

1. Provide a good shopping categories

   There are several categories listed at the main page such as home or home office, home & student learning, growing business, corporation, education and

government. Consumers can choose the appropriate category to purchase the products.

2. Integrated search engine

It provides many types of search method and can bound the search into a smaller scope such as product information, technical information, corporate information and product specifications.

3. Excellent technical support

The technical support can be divided into 4 sections, which are :

- Knowledge library - include Frequently Asked Questions, documentation library, issues and technical documents.
- Driver download - include recently posted device drivers, tutorial and a list of available device drivers.
- Site navigation - include site map, site help and search.
- Email - include technical support, customer service and other Email options.

4. Provide online payment

Consumers can choose to pay through various types of paying method such as credit card and cheque. Besides that, the payment procedure is easy and fast.

5. Attractive user interface

All the products are provided with picture, price and its specifications. The good combination of colour and other images will attracts the consumers to visit this again.

2.4 Summary

All this research was done mainly to gain information for this project. The information gathered includes development methodologies, development tools, web development software, security aspect of e-commerce and reviews on the local and foreign e-commerce application.

As for the development methodologies, this review of literature focuses mainly on two development models that are the Waterfall Model and Prototyping Model. Each model has its own features, which are different from one another. All the information gathered for both models were obtained from various resources. The development model that has been chosen for this project is mentioned in the following chapter.

The information gathered on development tools for the project was analyzed. All these information was obtained from the Internet using search engines and other resources. Information on four different server platforms such as Microsoft Windows NT, LINUX, UNIX and OS/2 had been gathered and analyzed. Each platform has its strengths and weaknesses. The web servers been studied were Microsoft Internet Information Server (IIS), Apache Web Server, Netscape Enterprise Server and Lotus Domino Go Web Server. The information gathered on programming languages such as Active Server Pages (ASP), PERL and Java Servlet are also being analyzed. The development tools chosen for this project will be mention in the next chapter.

As for the web development software, information was gained from sources like books and the Internet. There were three web development software been analyzed such as Microsoft Visual Interdev 6, Drumbeat 2000 and Microsoft FrontPage 2000. The chosen software will be mention in the next chapter.

Besides that, some research were carried out to gather information on the security aspect of e-commerce. The security aspect include the Secure Socket Layer (SSL), Secure Electronic Transaction (SET), E-Wallet, Digital certificate, Digital

Signature, Public-Key Infrastructure (PKI) and RSA (Rivest, Shamir and Adelman) cryptosystem.

Finally the reviews on local and foreign e-commerce application were done to complete the process of literature review. The research was done by browsing to some of the local and foreign e-commerce web site. The weaknesses on local e-commerce were identified in order for this project to overcome the current system. Meanwhile the strengths of foreign e-commerce were studied so that it can be adapted into this project. This is to overcome the weaknesses of the existing local e-commerce application.

CHAPTER THREE

METHODOLOGY

3.1 Project Description

This project entitled "Web-Based Agent for Transaction of Mercantile - Security Measures" is going to be a web-based e-commerce site for all local merchants and consumers only. It will act as an agent to allow and help all the local merchants to publish and sell their computer products on the web.

This project will mainly focus on the security measures of developing an e-commerce site. The project will use Secure Socket Layer (SSL) protocol to secure the transmission of data between the server and the consumers' computer. While the Secure Electronic Transaction (SET) protocol will be use to encrypt the credit card information so that only bank can read the information for verification.

This project can be divided into two major modules that are the administrator module and the user module. Each module consist of a few sections and each section has its own features as described below :

a) Administrator Module (Technical part)

The administrator module has the following sections :

i) Authentication Section
   - Only the administrator will be allowed to access this section by providing a password.

ii) Transaction and Maintenance Section
   - This section will allow the administrator to configure and troubleshoot the payment engine and network connection.

iii) Security Section
   - Include firewall settings, encryption and other security measures.

b) User Module

The user module has the following sections :

i) Main Page

- This page will display the shopping cart for consumers to add, edit or delete item from it. It also consists of Order Entry Page for the consumers to input their personal information.

ii) Payment Page

- This page will include delivery charges and the consumers have to input their payment information.

3.2 Approach

In order to develop a system or to make a project successful, an approach must be chosen. In the literature review section, two approaches were studied. After analyzing both approaches, the Waterfall Model was chosen for this project. The approach is described as below :

Waterfall Model

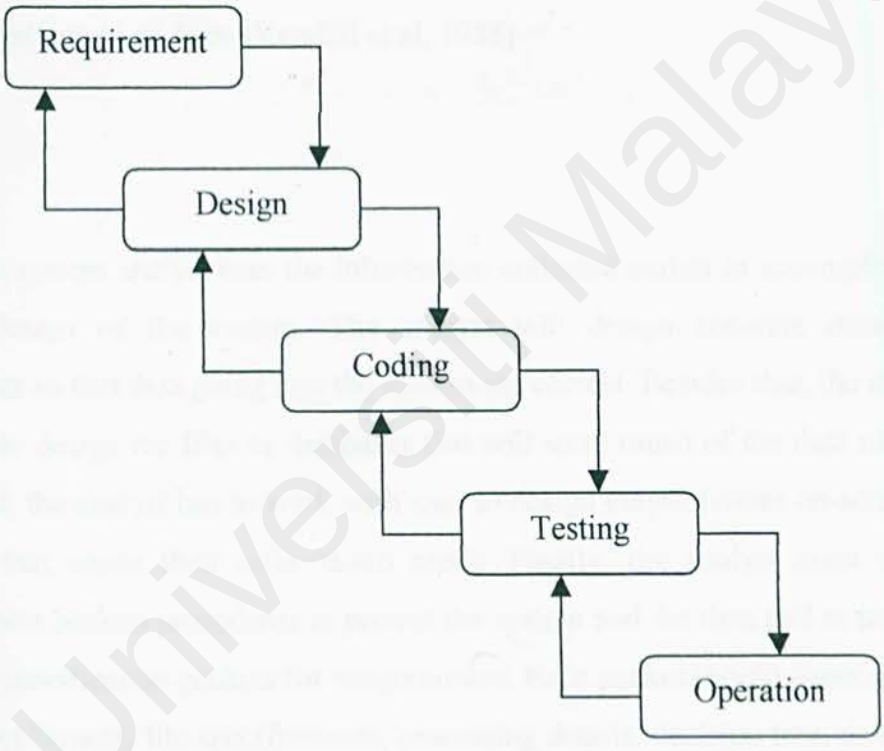

Figure 3.1 Waterfall Life Cycle Model

Figure 3.1 indicates the life cycle of the Waterfall Model. There are 5 stages in the Waterfall Model, which are requirement, design, coding, testing and operation. The details of each stage are described as below :

a) Requirement

In this first phase of the systems development life cycle, the analyst is concerned with identifying problems, opportunity and objectives. Both user and system analyst have to work together to identify the known requirements that must be met. After that, the system analyst has to define information requirements through several methods such as sampling and investigating hard data, interviewing, questionnaires, observing decision makers' behaviour and office environment. Next, the system analyst has to analyze the system needs by using data flow diagram to chart the input, processes and output of the system in a structured graphical form [Kendall et al, 1988].

b) Design

The system 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 analyst also has to design the files or databases that will store much of the data needed. After that, the analyst has to work with user to design output (either on-screen or printed) that meets their information needs. Finally, the analyst must design controls and backup procedures to protect the system and the data and to produce program specification packets for programmers. Each packet should contain input and output layouts, file specifications, processing details, decision tree, data flow diagram and the names and function of any prewritten code routines [Kendall et al, 1988].

c) Coding

During this phase, the analyst works with the programmers to develop any original software that is needed. Some of the structured techniques for designing and documenting software include structure charts, Nassi-Shneiderman charts and pseudocode. Besides that, the analyst also works with users to develop

effective documentation for software, including procedure manuals, online help, and Frequently Asked Question (FAQ). Programmers have a key role in this phase because they design, code and remove syntactical errors from the program. To ensure quality, a programmer may conduct either a design or a code walk-through to explain complex portions of the program to a team of other programmers [Kendall et al, 1988].

d) 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 [Kendall et al, 1988].

e) Operation

In this last phase of the system development, the analyst helps implement the system that involves training the users to handle the system. Some training is done by the vendors, but oversight of training is the responsibility of the system analyst. Additionally, the analyst needs to plan for a smooth conversion files from old systems to new one. This process includes converting files from old formats to new ones or building a database, installing equipment and bringing the new system into production [Kendall et al, 1988].

3.3 Justification

The Waterfall Model was chosen because of the following reasons :

1. Very structured
   The system is design using a logical flow.

2. Predictable

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

3. Involves user participation

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

4. Good visibility

   All the requirements can be identified and well defined.

3.4 Development Strategy

The development strategy is a set of steps or plans to develop a system. In developing a system, it is very essential to have this strategy, as it will help the developer to organize the project well. Every system development needs the user to determine the requirements. These requirements describe the system [Pfleeger, 1998]. A requirement is a feature that must be included in a new system. It may include a way of capturing or processing data, producing information, controlling a business activity, or supporting the management. The determination of requirements thus entails studying the existing system and collecting details about it to find out what these requirements are [Senn, 1989]. Without knowing the boundary, the entities and the activities, it is impossible to describe the system nor the software and how it will interact with the environment [Pfleeger, 1998].

This project is going to be developed using the Waterfall Model approach. As a result of it, the strategy or plan to develop this project will follow closely the steps that are involved in the Waterfall Model. The steps taken for this project is described below :

1. Identifying requirements

In developing a system it is very important to identify the system requirement. In order to identify them, a lot of information is needed. As for this project, information was gathered through research and interviews.

a) Research

- Research for this project was done on the Internet and books. The results of this research were described in Chapter Two.

b) Interviews

- An interview with a few staffs and the manager of Erasoft Systems Sdn. Bhd were carried out to gather information on how to build an effective and reliable e-commerce web site. The interview questions are enclosed in the Appendix B.

2. Requirements for this project

After going through all the information gathered and analyzing it, the requirement for this project was outlined. Basically, they are divided into functional requirements and non-functional requirements.

a) Functional Requirements

A functional requirement described an interaction between the system and its environment. Besides that, it also describe how the system should behave given the certain stimuli [Pfleeger, 1998]. The functional requirement in this project is the Administrator Module and the User Module. Description about these two modules has been described in the project description at the beginning of this chapter.

b) Non-Functional Requirements

A non-functional requirement or constraint describes a restriction on the system that limits one choices for constructing a solution to the problem

[Pfleeger, 1998]. A non-functional requirement for this project is describe as below :

i) User-friendly
   - Online help and Frequently Asked Question (FAQ) are provided for the users as a reference for them if they face any problem

ii) Attractive interface
   - With attractive interface, users especially consumers will be able to enjoy online shopping

iii) Fast retrieval of information
   - Users should be able to retrieve the information needed within reasonable time

3.5 Proposed Development Tools

After analyzing three software for this project, finally Microsoft Visual Interdev 6 was chosen as the development tool to be used in the development of this project. Details about the chosen software is described as follows :

3.5.1 Microsoft Visual Interdev 6

The major design goals behind the creation of MS Visual Interdev 6 focused on extending and enhancing features to provide a great experience both for the developer and the end user. The result is that developers have in MS Visual Interdev a new and improved tool that enables them to create a unique experience for the users of their applications. The following section explains why MS Visual Interdev 6 was chosen :

1. A More Visual Experience

   MS Visual Interdev 6 contains a greatly enhanced integrated development environment (IDE). It employs a tab metaphor to enable you to easily transfer between different views of your project. The properties window display the properties for any object in your Visual Interdev 6 project including HTML web pages, Active Server Pages (ASP), ActiveX controls and Java applets. This window enables the user to visually inspect the properties that have been set for an object and customized them to meet the needs of their application.

2. WYSIWYG Editing

   WYSIWYG editing enables user to visually create and edit web pages at the click of a tab and the drag and drop of an object.

3. Programming Support

   With this feature, it enhances the ability to refer to objects on other pages, thereby creating a truly integrated application.

4. End-to-End Debugging

   It includes the standard debugging features in RAD client/server tools.

5. Support for Development Teams

   Several development modes are included to support both individual and team development.

6. Database Wizards

   It provides several database wizards that reduces time for developing connection for the web pages. The wizards guide the user through the process of establishing connectivity with the database.

7. Support for the Latest Web Design Technologies

   This includes cascading style sheets (CSS) and Dynamic HTML. The Dynamic HTML technology supported in Internet Explorer 4.0 or above extends the

capabilities of standard HTML by providing more processing power on the Web client. JavaScript and VBScript are used for scripting languages and a combination of Dynamic HTML, ActiveX, RDS, JavaScript and Java objects are integrated into the client side portion of the application (Hoozer, 1998).

3.5.2 Other Software to be Used

Other related software to be used to develop this project is as follows :

1. Server Platform - Microsoft Windows NT Server 4.0
2. Web Server - Microsoft Internet Information Server (IIS) 4.0
3. DBMS - Microsoft SQL Server 7.0
4. Programming language - Active Server Pages (ASP)
5. Payment and transaction - Netlife MPOS 1.2 and Netlife Adapter (Depending on the approval of the vendor for evaluation copy)

3.5.3 Hardware Requirements

- Pentium II 233 MHz or above
- Memory - 64 MB RAM or above
- 4.5 GB hard disk or above

3.6 Statement of Expected Outcome

Once this project is developed, it is expected to be an educational site on the web with the following features :

- An Administrator Module that will be able to manage the authentication, transaction, maintenance and the security measures.

- User Module with main page which consist of shopping cart and order entry and the payment page which contains delivery charges and payment interface.

CHAPTER FOUR

SYSTEM DESIGN

4.1 System Design

Design is the creative process of transforming the problem into a solution and the description of the solution [Pfleeger, 1998]. The processes in designing this project are described below :

4.1.1 System Architecture Design

System architecture design can be divided into two parts as shown below :

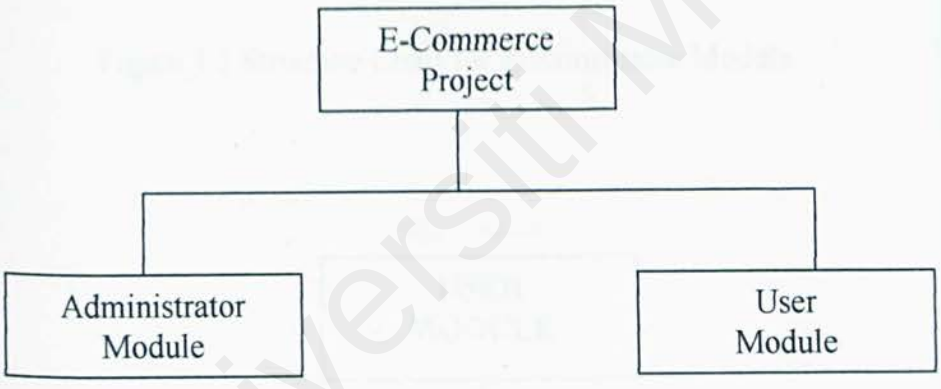

Figure 4.1 System Architecture Design

4.1.2 Structure Chart

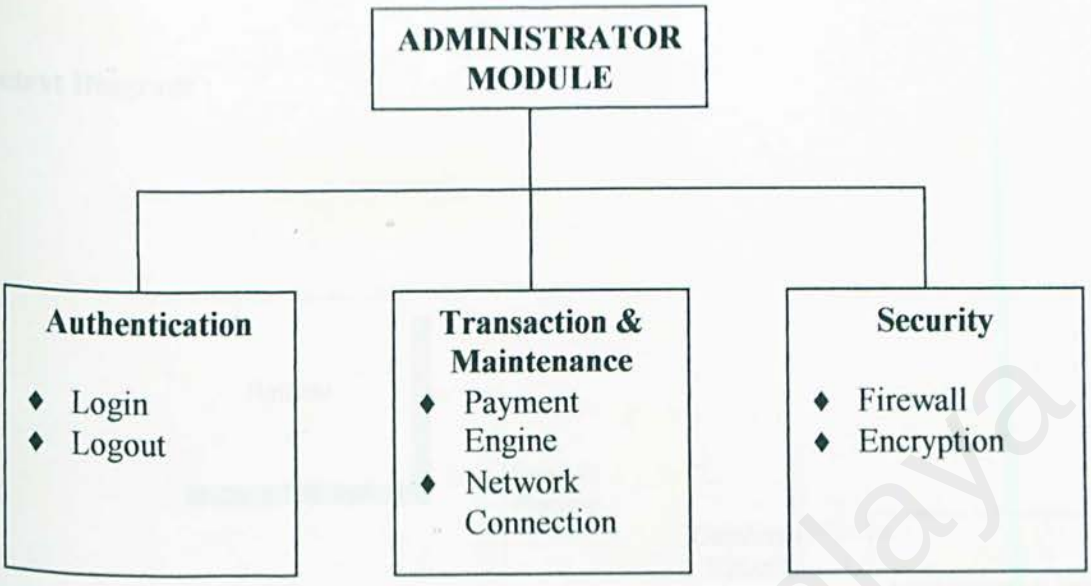

Figure 4.2 Structure Chart for Administrator Module

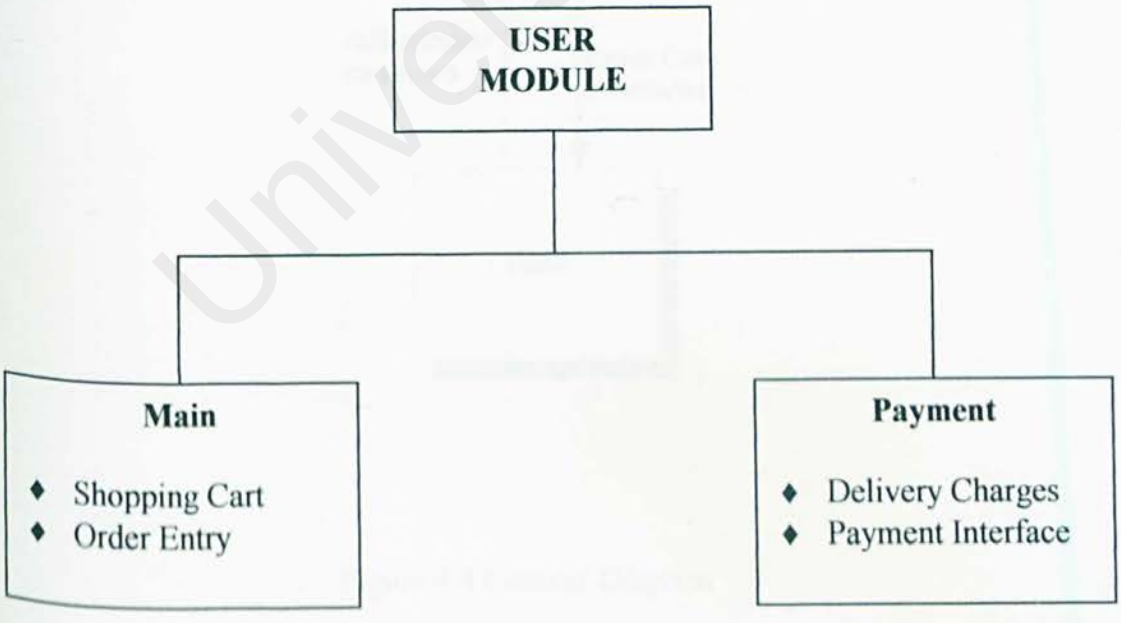

Figure 4.3 Structure Chart for User Module

4.2 Data Flow Diagram

Context Diagram :

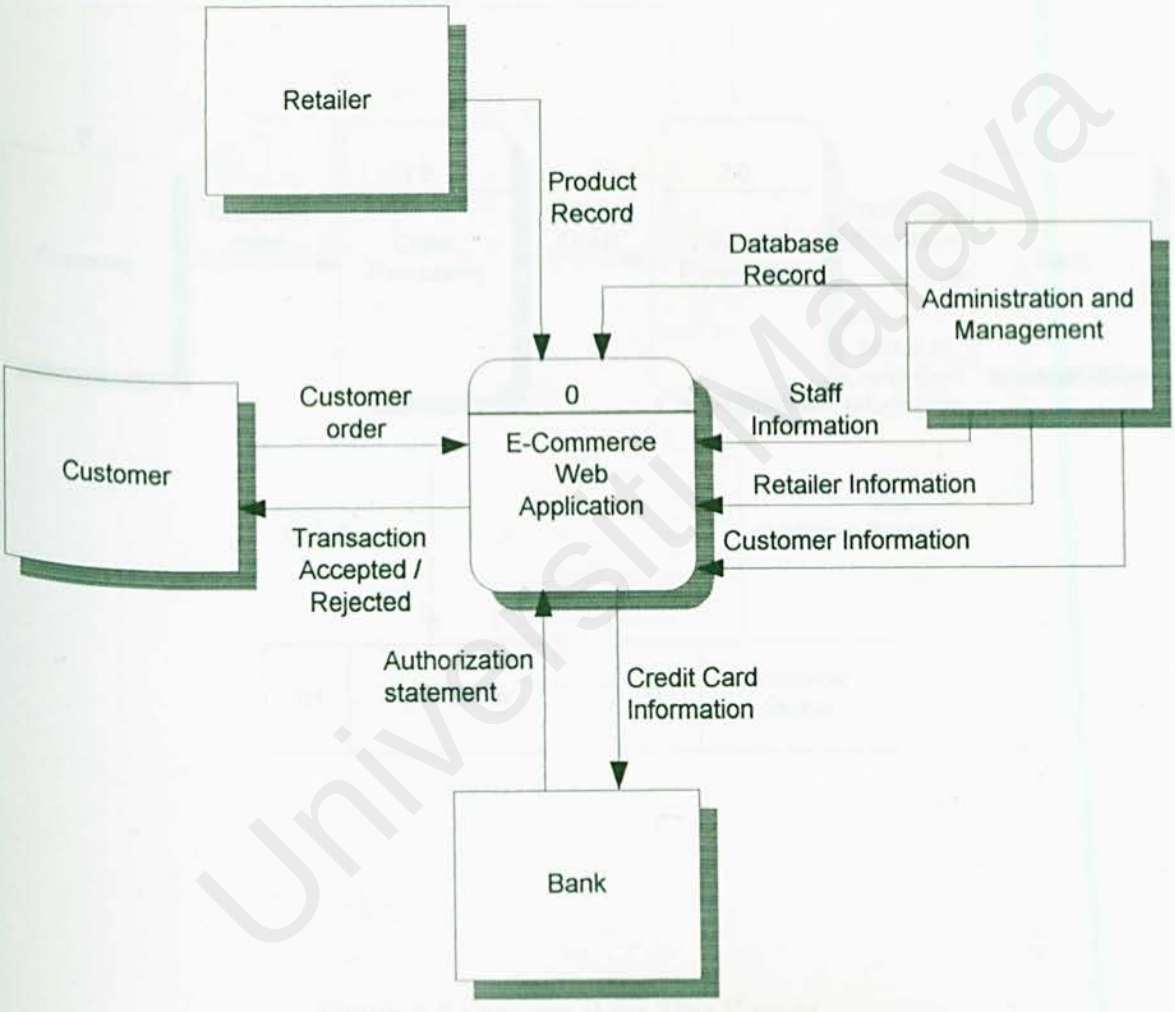

Figure 4.4 Context Diagram

Diagram 0 :

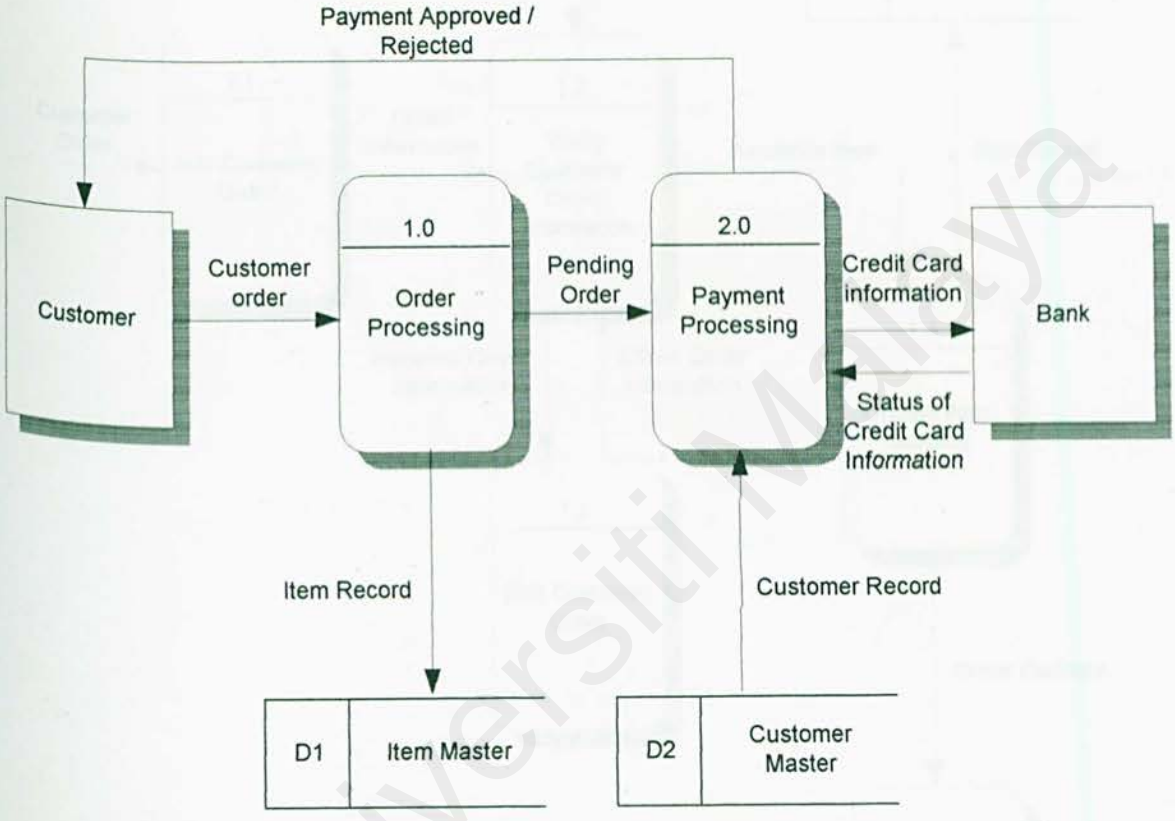

Figure 4.5 Diagram 0 for This Project

Child Diagram :

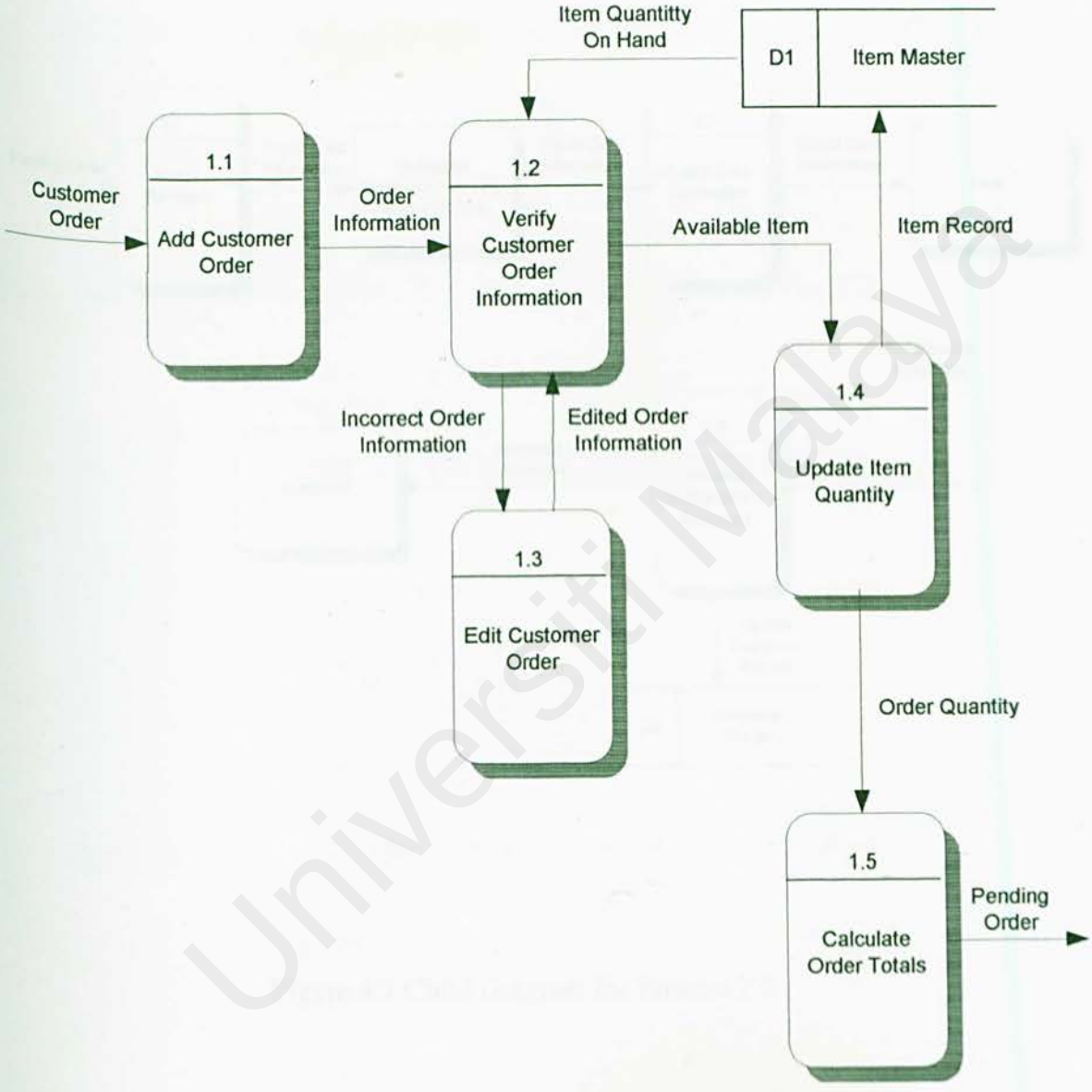

Figure 4.6 Child Diagram for Process 1.0

Child Diagram :

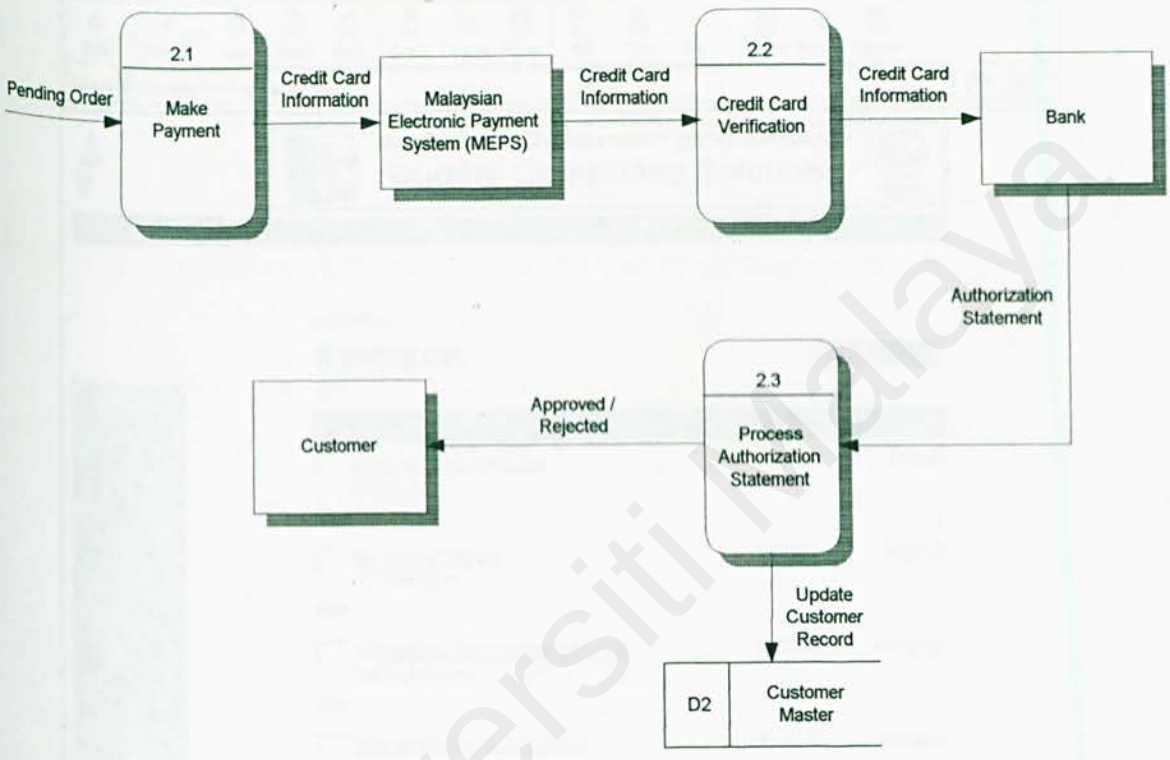

Figure 4.7 Child Diagram for Process 2.0

4.3 Interface Design

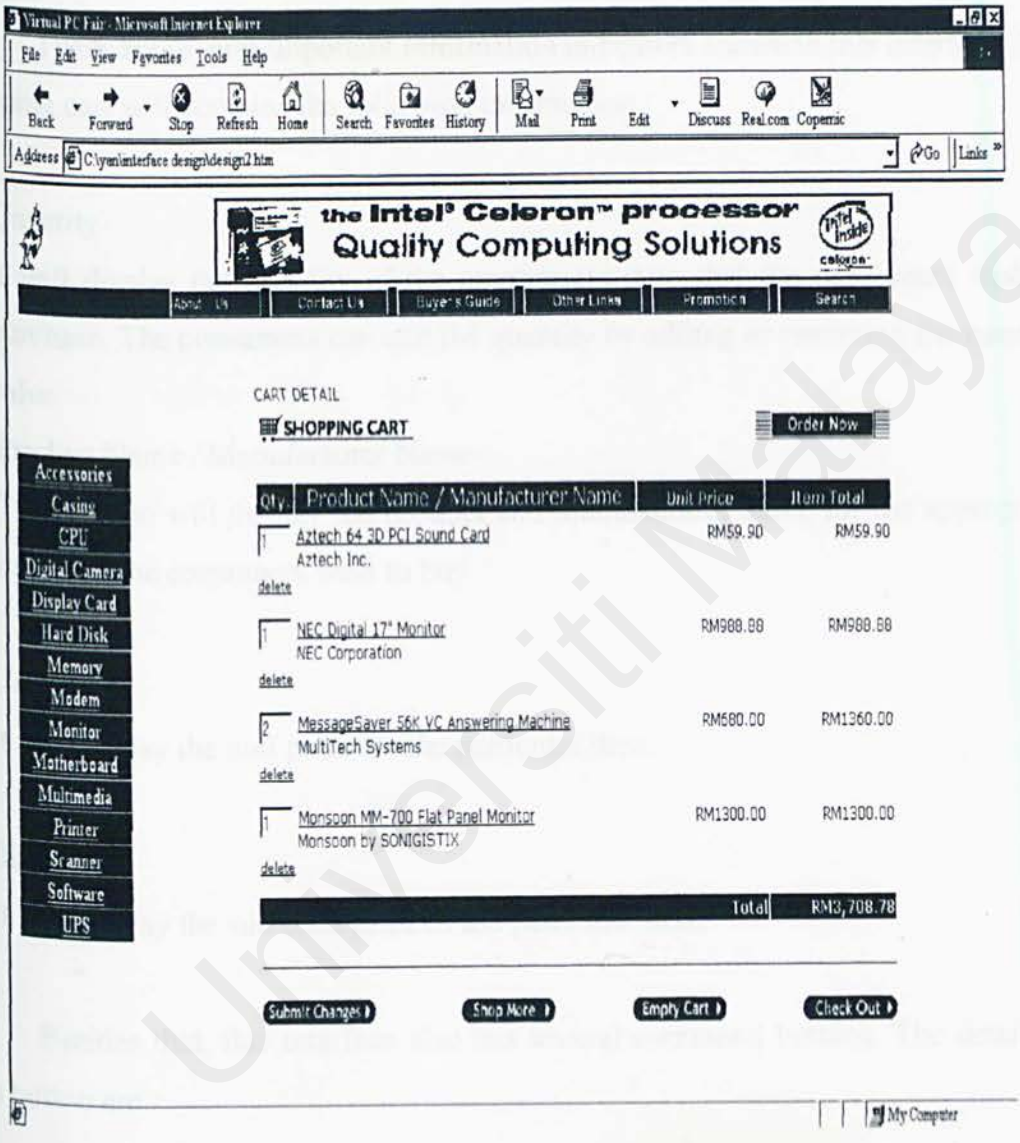

Figure 4.8 Interface Design for Shopping Cart

Figure 4.8 indicates the interface design for shopping cart. The concepts of shopping cart is basically same as the shopping basket used by the consumers in a shopping mall. The consumers can add any items that they wish to buy into the shopping basket.

There are several important information indicators shown in this interface. The shopping cart will contains the following information :

- Quantity
  It will display the quantity of the appropriate item that the consumers wish to purchase. The consumers can edit the quantity by adding or removing the quantity value.
- Product Name / Manufacturer Name
  This section will display the product and manufacturer name for the appropriate item that the consumers wish to buy.

- Unit Price
  It will display the unit price for the particular item.

- Item Total
  It will display the sub-total price of the particular item.

Besides that, this interface also has several command buttons. The details of each button are :

- Submit Changes
  This button is use when the consumers finished updating the quantity of item that they wish to purchase. It will update the record in the shopping cart.

- Shop More

  This button is use if the consumers still want to look for other items that they wish to purchase.

- Empty Cart

  This button is use when the consumers want to clear all the record in the shopping cart.

- Check Out

  This button is use when the consumers finished their shopping and ready to make payment. It will go to payment page so that the consumers can enter their payment information such as delivery address.

CHAPTER FIVE

SYSTEM IMPLEMENTATION

5.1 System Implementation

The requirements 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 designs into program codes.

5.2 Development Environment

Development environment has certain impact on the development process of a good software system. The suitability of the hardware and software chosen is very important because it will not only help to expedite the system developments but determine the success of the project. The hardware and software tools used to develop the entire system are as below :

5.2.1 Hardware Requirements

The hardware used to develop the system are listed :

- Pentium II 233 MHz
- Memory - 64 MB RAM
- 4.5 GB hard disk

5.2.2 Software Tools Requirements

Table 5.1 illustrates the software tools used to develop the entire system :

Software	Purpose	Description
Microsoft Windows NT Server 4.0 (Service Pack 5)	System requirement	Operating System [Final Stage]

Microsoft Internet Information Server 4.0	System requirement	Web Server host [Final Stage]
Microsoft Personal Web Server (PWS)	System requirement	Web Server [Earlier Stage]
Netlife MPOS 1.2	System requirement	Payment software [Server-based]
Maybank eCommerce Wallet 1.2.10	System requirement	Payment software [Client-based]
Microsoft Visual Interdev 6.0	System development	Coding the web pages
Microsoft Internet Explorer 5.5	System development	Web browser
Microsoft (R) Notepad 4.0 (Build 1381, Service Pack 5.0)	System development	System file creation (example : *.ini)
Microsoft FrontPage 98	System development / Interface design	Coding the web pages and image design
Microsoft Access 2000	System development	Database design [Earlier stage]
Microsoft SQL Server 7.0	System development	Database Server [Final stage]
Visio 4.0c for Microsoft Windows	System design	Diagram creation (example : DFD diagram)
Adobe PhotoShop 5.0	Interface design	Image design and creation
Macromedia Flash 5.0	Interface design	Animation for SET transaction

Table 5.1 : Summary of Software Tools Used

5.3 System Development

System development consists the used of methodology chosen, web pages coding, web-based development tools, database connection and payment processing tools. The details are illustrated as below :

5.3.1 Methodology

This project is developed using the Waterfall approach. The development of this project will consists 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.

5.3.2 Web Pages Coding

An Active Server Page is primarily a scripting environment and languages used to develop an ASP are HTML and VBScript or JavaScript. The challenge of coding in ASP is of determining and separating the HTML source code from the scripting counterpart.

For client-side scripting, it must be delimited by the <SCRIPT>...</SCRIPT> tags. On the other hand, server-side scripting requires the RUNAT attribute set to Server so that the script should be executed on the server rather than the client (browser). An example is as below :

```
<SCRIPT LANGUAGE = "VBScript" RUNAT = "server">
....
</SCRIPT>
```

The easiest way to add a script to an Active Server Page is by using the script delimiters <% and %>. Any text enclosed within these delimiters will be processed as a script.

The preparation of a HTML and ASP document involves endless cycle of testing and modifying of the ASP source codes, loading the file in the browser for viewing and validating. Further changes will be made if necessary.

5.3.3 Web-based Development Tools

Microsoft Visual Interdev 6.0 is used as the main development tool for this project. This tool enables easy performance of the many complex programming and database tasks required in the creation of a Web site, as well as the incorporation of HTML formatting and layouts, graphics and other multimedia components.

Microsoft Visual Interdev 6.0 will creates a second copy of the files on the local computer while performing tasks like adding files to the Web site or editing any of the existing files. This is called the working copy and whenever these working copies are saved, Visual Interdev 6.0 will updates the file on the Web server as well.

All the graphics and animations in this project are created using Microsoft Front Page 98, Adobe PhotoShop 5.0 and Macromedia Flash 5.0. The Data Flow Diagrams are created using Visio 4.0c for Microsoft Windows.

5.3.4 Database Connection

The database for this project is initially created using Microsoft Access 2000 and is later migrated to the Microsoft SQL Server 7.0 using the Access upsizing wizards. By using Microsoft Access 2000, creating and modifying the tables and their relationship is made easy.

ActiveX 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 :

Driver = {SQL Server}; Server = server_name; Database = database_name; UID=; PWD=

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

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

5.3.5 Payment Processing Tools

The main tools used for payment processing are Netlife MPOS 1.2 and Maybank eCommerce Wallet 1.2.10.

Netlife MPOS 1.2 is a server-based software which runs on Microsoft Windows NT 4.0 with NT File System (NTFS). It provides the payment authorization and processing. It will also bridges the gap between the credit cardholder and the payment host while providing authentication and secure transfer of information.

Maybank eCommerce Wallet 1.2.10 is a client-based software which works with the client's web browser. It is launched automatically when the users are shopping on the Internet and choose to pay using the Secure Electronic Transaction (SET) standard. This program allows users to safely use their credit card to make SET purchases of goods over the Internet.

Maybank eCommerce Wallet 1.2.10 also helps users to manage their credit card accounts for SET purchases and stores their purchase information. In order to

enhance the security measures, several features are embedded into this program such as :

- Encrypts the credit card information to protect it when it is sent over the Internet.
- Maintains the details of each order placed by the user.
- Allows users to check the status of their orders.
- Uses digital certificates to authenticate the merchants and payment card companies associated with the transactions.

CHAPTER SIX

SYSTEM TESTING

6.1 Introduction

Software testing is one of the main phases in the Waterfall Life Cycle model. In this phase, the process of testing and debugging are done to detect defects and bugs of a system. These processes are usually done incrementally with system development.

This phase is also often referred to as Verification and Validation (V&V). Verification refers to the set of activities that ensure the software correctly implements a specific function. Validation refers to a different set of activities that ensure the software has been built is traceable to user requirements. A successful test is one in which no errors are found.

The objectives of software testing are [Pressman, 2000] :

- To reveal different classes of errors and do so with a minimum amount of time and effort
- To demonstrate that software functions appear to be working according to specification
- To demonstrate that behavioral and performance requirements appear to have been meet

In addition, data collected as testing is conducted provide a good indication of software reliability and some indication of software quality as a whole. However, testing cannot show the absence of errors and defects, it can show only that software errors and defects are present [Pressman, 2000].

This project was tested with the following generic characteristic :

- Testing begins at the module level and works "outward" toward the integration of the entire system
- Different testing techniques are appropriate at different points in time
- Testing and debugging are different activities, but debugging must be accommodated in any testing strategy

The testing process that has been carried out is explained as below :

6.2 Unit Testing

Unit testing focuses verification effort on the smallest unit of software design which is the software component or module. All the important control paths in this project are tested to uncover errors within the boundary of the module. The relative complexity of tests and uncovered errors is limited by the constrained scope established for unit testing. The unit test is usually white-box oriented and the step can be conducted in parallel for multiple components.

The tests that occur as part of unit tests are 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 operates 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.

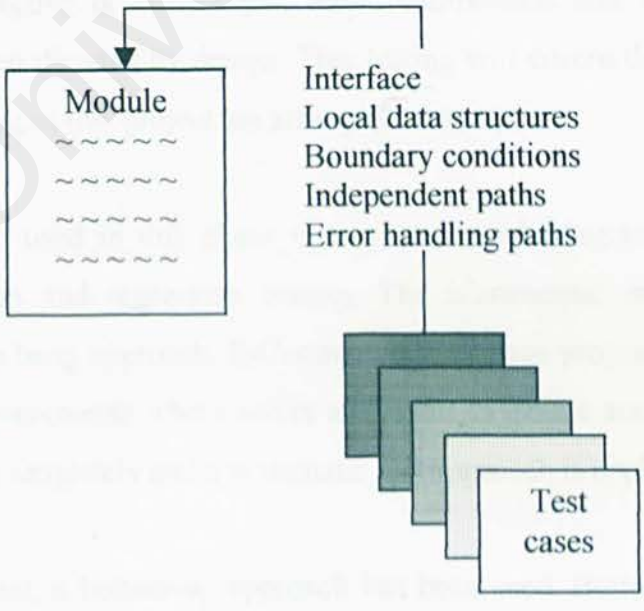

Figure 6.1 Unit Test

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

a) Boundary value analysis

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

b) Error handling paths

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

c) All possible independent program paths are executed

Ensure that the control structures are implemented correctly.

6.3 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 interfaces such as module calling in this project are arranged correctly.

The approach used in this phase is an incremental integration strategy, the bottom-up integration and regression testing. The incremental integration is the antithesis of the high bang approach. E-Commerce Web page program 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 reasons) do not introduce unintended behavior or additional errors.

6.4 Validation Testing

At the culmination of integration testing, this project is completely assembled as a package, interfacing errors have been uncovered and corrected. A final series of software tests that is the validation testing are 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 outlines the classes of tests to be conducted and a test procedure 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 uncovers 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.

6.5 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 purpose, 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 system to fail in a variety of ways and verifies that recovery is properly performed. If recovery is automatic (performed by the system itself), then reinitialization, checkpointing mechanisms, 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 attempts 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 SEVEN

SYSTEM EVALUATION & CONCLUSION

7.1 System Evaluation 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, E-Commerce Website, 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 this Electronic Commerce project. These includes :

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

There are many software tools available to develop an Electronic Commerce 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, coursemates 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 ASP and VBScript

Previous knowledge in traditional, two-tier non web-based system does not seem to solve the lack in web-based system. Since there was no prior knowledge of programming in ASP and VBScript, there was an uncertainty on how to organize the codes in a web page.

These new programming languages and concepts were never taught before and to implement such an 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 ASP and VBScript 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 trial and error during the coding phase.

7.2.3 Readability Problem in ASP

Almost all web-based programming languages do not support for variety types of variable. It increases the writability for programmer but at the same time decrease the readability for the programmer. Problems become more tedious when there are bugs detected in the program. Since the readability of the program is decreased, then the code maintainability also decreased. It is very difficult to debug the errors especially semantics errors that are unable to be detected by the debugger engine.

In order to minimize the problem in this area, a series of testing must be taken if the components are to be used in implementation of this project. Minimization in using the component is need for a stable system.

7.2.4 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 Server. 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 steps is not correctly done, then the whole operation will failed.

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 Web site.

7.2.5 Lack of Knowledge in Generating Digital Certificate for The Server

Throughout the development of this project, the implementation of security measure involves digital certificate. The main purpose of the digital certificate is to verify the identity of the merchant or company of a particular Web site.

The main problem faced is the lack of knowledge on how to generate a digital certificate for a server and what kind of software tools to be used. Furthermore, some knowledge on computer networking and security are needed in order to grasp the concept and procedure involved in generating the digital certificate.

In order to solve the problem, discussion with coursemates and seeking advises from lecturer were carried out. Finally, the digital certificate was successfully generated using the Microsoft Certificate Server, which can be found in the Windows NT Option Pack.

7.3 System Strengths

During the development of this project, several system strengths were identified and described as follows :

7.3.1 Provide An Easy to Use Tool

The commands and the layout of this project are simple and well organized, therefore it is easy to use, simple to learn and understandable. Normal users with some computer knowledge will find the Web page is easy to handle.

7.3.2 User Friendliness and Easy to Use Interface

Some useful Graphical User Interface (GUI) such as command buttons, check boxes and drop-down list boxes are provided which attract the users to navigate through the system and give faster access. This user-friendly interface can shorten the learning curve and reduce training costs, which include money and time.

The menu-driven and pop-up windows or pull-down menus are built to facilitate the individual needs of the users.

7.3.3 Provide Database Access

All the data are organized and stored in the form of database using Microsoft SQL Server. It is a real-time database information and any changes made to the records can be updated instantly to the E-Commerce database.

7.3.4 Security Features

Security issues are taken into consideration for the maintenance module so as to prevent any unauthorized users from manipulating the data stored in the database. The maintenance module is protected with password and only the administrator is allowed to update and add data into the database.

The system is protected by the Secure Socket Layer (SSL) protocol when collecting sensitive information from the users such as personal and credit card information. Besides that, server certificate (a type of digital certificate) is used to facilitate the SSL protocol. The use of server certificate is to ensure the users that they are visiting a legitimate website and the information given by them are protected.

For payment processing, the payment information is encrypted using the Secure Electronic Transaction (SET) protocol. This must be used in collaboration with Electronic Wallet, a browser companion software which is used to purchase products over the Internet.

7.3.5 Fast Response Time for Document Retrieval

The Web pages are designed in such a manner that they are loaded in a reasonable amount of time to ensure users need not wait for a long time to view the pages. Heavy graphics are avoided and ActiveX controls are kept to the minimum wherever possible.

7.3.6 System Transparency

System transparency refers to the condition where the users do not need to know the underlying structure of the system, where the database resides, the database management system and anything related to the system design. For example, information retrieval and downloading of records are similar to a system accessing the

local database. This is done to ensure that the user are not confused when retrieval information.

7.4 System Limitations

Owing to the time constraint and the constraint of the programming language itself, there were some limitations in this E-Commerce system. These include :

7.4.1 Real Time Transaction Limitation

The major limitation of this system is the lack of real time transaction. This is because there is no participation involves from the local bank. The transaction cannot be sent to the bank for authentication and verification. Thus, the Secure Electronic Transaction (SET) protocol cannot be fully utilized.

7.4.2 Lack of Firewall

The second limitation of this system is the lack of use of firewall. Firewall normally is used to create a security checkpoints at the boundaries of a private network. By providing the routing function between the private network and the Internet, firewall inspect all communications passing between the two networks and either pass or drop the communications depending on how they match the programmed policy rules.

Firewall is not implemented together with this system is due to the factor that this system does not have any real-time online transaction. The features of firewall cannot be fully utilized since there are no incoming or outgoing communications between this system, Malaysian Electronic Payment System (MEPS) and the local banks. Based on the reason stated, the implementation of firewall was cancelled.

7.5 Future Enhancement

Further development and many new ideas have come about while the system was being implemented. Owing to time constraint and other factors, not all of the ideas could be incorporated into the system. It is hoped that the following aspects could be considered in future :

7.5.1 More Administration Task

Administration task can be further enhanced to include more features to ease the maintenance process. Among the features that may be included are report generating, analytical tools and database backup.

7.5.2 Real Time Online Transaction

A real-time online transaction can be included in order to achieve the complete process of the Secure Electronic Transaction (SET). This must involved the co-operation of the local banks that support SET transaction. Currently, there are 4 banks in Malaysia that support SET transaction.

If this feature is added, then the consumer can fully utilize their credit card to purchase over the Internet. The confidence level of local consumers towards online purchasing will increase if this feature can be successfully implemented.

7.5.3 Implementation of Firewall

Firewall must be implemented if the system will support real-time online transaction in the future. This is very important because the connection between the system and the local banks must be keep as secure as possible.

Firewall can be considered a border security because it will inspect and then approve or reject each connection attempt made between the system and external networks. It also allows the administrator to centralize all external security services in a machine that are optimized for and dedicated to the task.

With the implementation of firewall, all the sensitive information such as the client's credit card number or account number can be protected from any intruders. This is to ensure the system will provides a reliable payment system and the transaction can be successfully transmitted to the local banks.

7.5.4 Other Language Support

Future enhancement for this system will include other language support. This will enable information to be displayed in different languages such as Chinese, Japanese, French and others. This will broaden the usage of the system as the system will be used by the users from different countries with different national languages.

7.5.5 Error Detection Features

This system actually needs a more comprehensive error detection feature to ensure that only valid input is being passed to the server and it is done through client-side scripting. This is important in ensuring that the E-Commerce system is robust and easy to maintain the reliability of the system.

7.6 Conclusion

Overall, this project has achieved and fulfilled the objectives and requirements as an Electronic Commerce web-based application that provides the opportunity of purchasing computer products over the Internet. The completion of this project will also encourage the consumers in Malaysia who possesses a credit card to accept electronic business as an integral part of their daily lives.

A lot of research and studies was done during literature review in order to gain the information needed for the development of this project. The information gathered includes development methodologies, development tools, web development tools and security aspect of e-commerce. All these information were analyzed to determine the suitability of the development methodology, development tools and security measures to be used in this project.

Throughout the development of the system, a lot of knowledge was gained such as knowledge in setting up Windows NT Server, Internet technologies, programming and concepts as well as using Microsoft SQL Server. Programming in ASP, HTML and VBScript proved to be a valuable experience. ASP technology has captured the attention of many software and web developers. The core of the ASP technology lives in the implementation of object-oriented technology. As such, the object-oriented programming skill has improved.

Apart from that, knowledge also gained on how to implement an effective security measures in e-commerce system. The security aspect been adapted in this project includes the use of Secure Socket Layer (SSL), Secure Electronic Transaction (SET), Digital Certificate and encryption. In addition, payment processing will involve the use of Electronic Wallet and Netlife MPOS 1.2.

Finally, all the problems faced and experiences gained during the system development should be useful in the future endeavors. This is because electronic

commerce has shown its potential power to revolutionize industry processes, structures and redefine the competitive landscape for business around the world.

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