The Development of Price-Wise E-Commerce Enabled Web Site

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Abstract

Electronic commerce or e-commerce is a new paradigm that changes the traditional way of managing business whereby it allows buyers, individual or organization, to search for products anywhere in the world and makes deal electronically. The advancement of network technology and the exponential growth of Internet and World Wide Web have been the key driving force for the rapid growth of e-commerce. However, adopting e-commerce into the business management involves huge investment due to expensive applications software. This paper describes an alternative solution of implementing functional e-commerce enable Web site that is cost-effective. This is achieved by employing freeware tools that provide the same capability of commercial software. The system developed delivers all the required services of e-commerce transaction as well as security services. This paper also acts as a guideline to small local companies in implementing e-commerce.

Keywords: E-commerce, World Wide Web and security.

1.0   Introduction

The advancement in networking technologies and the explosive growth of Internet have revolutionized the traditional way of conducting business transactions. It brings about to the new business environment known as electronic commerce or e-commerce. E-commerce can be defined quite broadly as the way of conducting business with the assistant of telecommunications, and of the telecommunications-based tools. More specifically it is the ability to conduct business via electronic networks such as Internet and the World Wide Web. The scope of e-commerce can be treated as being as narrow as `electronic trading', or as broad as `electronic business'.

E-commerce aims at supporting the complete external business processes that include establishment of initial contact between organization and their customers, exchange of information, pre- and post-sales support, electronic payment and distribution [1]. E-commerce promises to alter the way business is performed. The Internet and Web provides a distribution channel that can span the organization boundaries and enable factors for virtual enterprises.

E-commerce gives several advantages to business and thus brings the business into the competitive edge. These advantages include:

i.   Wider presence of business provided by the online storefront that can reach millions of people around the world at a low cost.

ii.   24-hour opening time to customers that has access to Internet connection with no extra investment on the part of the organization.

iii.   Faster processing time by accepting online application and in return reduce the processing cost and thus improve customer services.

iv.   Better marketing strategy through better customer knowledge. This is achieved by analyzing customer-buying habits and preferences based on the capture information.

With these positive advantages, more and more businesses are starting to integrate e-commerce functionality into their Web site. Forrester Research, Cambridge, Mass., predicts that 65% of companies with 5,000 or more employees will have some sort of e-commerce functionality on their Web site by the end of the year 2000 and it will grow to 92% by 2002 [2]. Nevertheless, many small businesses today are also using the Internet to attract new customers, build relationships with suppliers, and cut the costs of serving established clients. With the Internet, small businesses have an efficient means to match the global reach of larger firms. However, the common stumbling block that discourages small businesses from adopting e-commerce is the cost of implementing the e-commerce application. This is because the developing cost may varies from a few thousands to hundredths of thousands of dollars.

This paper proposed an alternative solution for small businesses in developing a price-wise e-commerce Web site. In order to fulfill the target of cost effectiveness, the solution presented in this paper will try to minimize the development cost of Web site but still able to produce a high quality system. The main logical step to reduce the development cost is to use free but reliable software that are available on the Internet such as *Apache* and *Tomcat* instead of commercial software example *Microsoft* products. With the identified collection of software, the research will explore the techniques of integrating the software components so as to build a robust and secure e-commerce Web site that is expandable as well as reduced development time.

2.0   Components of Web Enable E-Commerce System

E-commerce web site can be classified into two categories. In the first category, the main objective of the web site is to supplement traditional marketing activities example distributing the news and information of the organization to the customers or clients. This information may include the organization's information product's information and services. In the early days of Internet, almost all of the e-commerce web sites fell into this category. Nowadays, most e-commerce web sites belong to the second category that is selling site whereby the objective of the site is to close the sale electronically over the Internet. These web sites is designed to include a comprehensive product information and online transaction for purchasing [3]. The site usually has three sections:

i.   Marketing information and also other added value information that is to attract customers and give them confidence in the retailer.

ii.   The catalogue that contents detail information on product benefits, specifications, and pricing.

iii.   Order processing that includes method for specifying and paying for the order.

Therefore the services that are required by e-commerce software must include handling of product catalog, shopping cart and payment functions. To provide the these services, the Web site to be built must have the basic minimum components that include:

i.   Operating system

ii.   Web server
iii.   Mail server
iv.   Web application
v.   Database
vi.   Security components such as firewall and security protocol.

There are several commercial software in the market that can be employed by organization to develop their e-commerce Web site such as IIS (Microsoft), iPLANET (SUN Solaris) and Cold Fusion (Allaire).

3.0   Proposed System Component

E-commerce application can be modeled as a 6-phase process, comprising of:

i.   pre-contractual activities
ii.   contractual activities
iii.   ordering
iv.   logistics (i.e. delivery of goods)
v.   settlement
vi.   after-sales services

In order to build price-wise e-commerce enable Web site that fulfill all the requirements and services, a thorough study has been done to select for the suitable software (tools) that is readily available on the Internet. The first task is to determine the operating system platform for the host that will be used to develop the e-commerce system. After much consideration, *LINUX* operating system has been chosen since low costing is the main aim to achieve in this project. Beside of being a shareware produce, *LINUX* is well known operating system and has been repudiated for its robustness by other users. Determining the other supporting software is much easier once the platform have been decided. Table 1 shows mapping the selected tools against the commercial software. All of the tools selected are free software and are under the GNU Public License that guarantees freedom to share and change the free software [4].

Table 1: The Mapping of Commercial Software to Free Software

Function	Commercial Software	Free/Shareware
Operating System	Windows2000, Windows NT, Unix	Linux
Web Server	IIS, Cold Fusion	Apache
Mail Server	IIS	Sendmail
Application Server	IIS, Cold Fusion	Jakarta-Tomcat
Database	MSSQL, Oracle	MySQL, PostgreSQL

3.1   *LINUX* Operating System

LINUX is a variant of the well-reputable *Unix* operating system. Like all other variants, *LINUX* is a very stable operating system. It suitable for small to medium sized business seeking to host Internet services because of its characteristics of being fast, stable and cost-effective solution [5]. *LINUX* has better documentation than most operating system, and all of it is on-line, so it keeps itself current and is search-able [6].

3.2   *Apache* Web Server

Apache is a public domain Web server developed by a loosely knit group of programmers. As a result of its sophisticated features and excellent performance, Apache has become the world's most popular Web server. It well known for highly configurable, able to handle heavy load, and high speed in serving web pages. In addition to this, *Apache* is extensible with third-party modules and can be customized by writing 'modules' using the Apache module API. It is used to host more than 50% of all Web sites in the world and developers have cited *Apache* and *Sendmail* are best-of-breed server software [7].

3.3   *Sendmail* Mail Server

Sendmail mail is another typical application found on most *Unix* server. Just like *Apache* web server, *Sendmail* is also a highly configurable as well as effective mail server and are widely accepted with Web developers.

3.4   *MySQL* and *PostgreSQL* DBMS

Database management system (DBMS) is a very crucial element in e-commerce Web site. A fast DBMS can give a quick response to the user, while a robust system can do better in disaster recovery. To achieve these features, the system selects *MySQL* and *PostgreSQL* as its DBMS. Both of the DBMS use a subset of the features of ANSI SQL. This allows a program or user to store, manipulate and retrieve data in table structures. They also have a sophisticated and flexible client-server architecture [8].

MySQL is well known for its incredible speed, but it lacks certain critical functions like 'rollback & commit' [9]. This is not suitable for recording the transaction that has taken place. However to overcome these shortages, *PostgreSQL* is employed in the system. *PostgreSQL* is a fully standardize DBMS and iIt has all the critical functions not found in *MySQL*.

In the system, *MySQL* is used to store information that needs fast retrieval time so as to generate dynamic web pages, while the *PostgreSQL* is used to record all transactions that has taken place.

3.5   *Tomcat* Application Server

Servlet technology is replacing CGI. So in our system, we will implement servlet technology on the server side processing. *Apache* web server, by its nature, does not support servlet technology. So in order to enable servlet processing, we need a servlet container. *Jakarta-*

Tomcat is another *Open Source* software, a servlet container, developed specially for integration with the *Apache* web server.

4.0   The Design

Figure 1 shows the internal design of the system. All together there are eight main components and that includes:

i.   Firewall,
ii.   *Apache* web server,
iii.   *Sendmail* mail server,
iv.   *Tomcat* application,
v.   *SET* server,
vi.   *MySQL* DBMS,
vii.   *PostgreSQL* DBMS, and
viii.   Database applications.

least minimize the chances of hacker intrusion. *Apache* web server, as its name indicates, is responsible for handling web pages request where as *Sendmail* is a mail server that handles the emails that coming to or going from the system. *Tomcat* application server is the most important and critical component in the system. It is responsible for the server side processing tasks that include generating dynamic web pages and handle the online transactions. *SET* server is a special server that will validate the clients' credit card numbers. *MySQL* and *PostgreSQL* DBMS are used to store the products' information, members' details and transaction records. Lastly, database applications are a group of GUI applications that provide a user-friendly environment to manipulate the two databases employed in the system.

All the above-mentioned software, besides *SET* server, is freeware product.
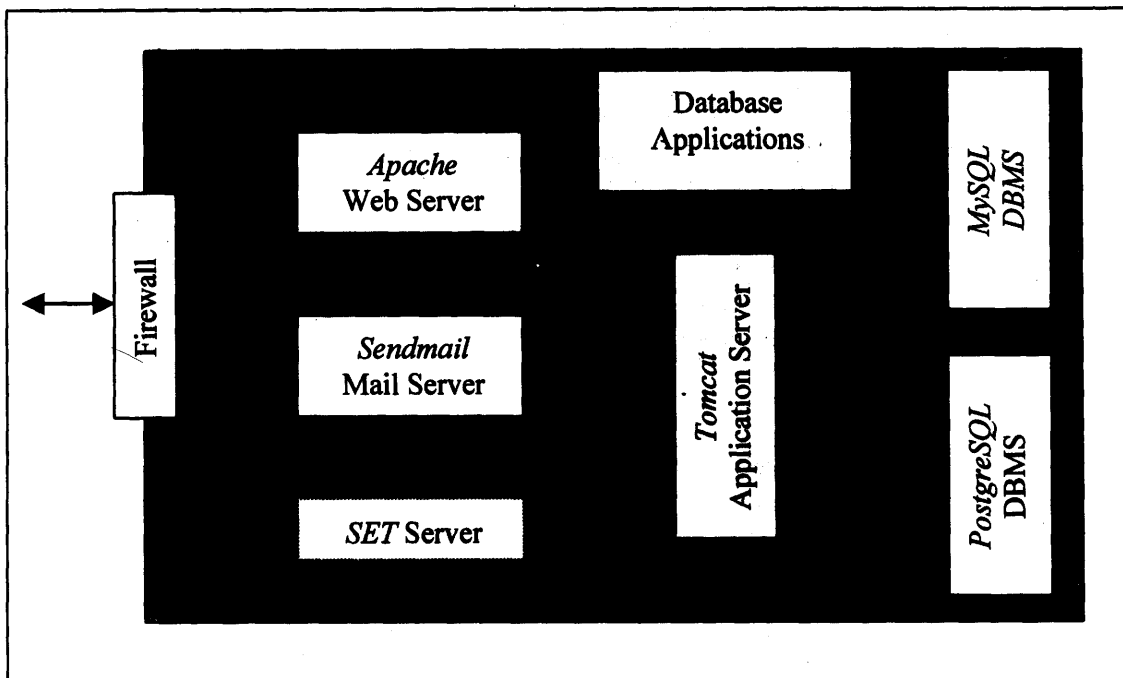
Firewall is the main gate that opens up the system to the Internet. It will prevent or at

Figure 1: Internal design of the system

4.1 Essential Services

A complete e-commerce web site should be easy to use and understand as well as provide all the required services. This is often the work of a professional web designer. On the other hand, the server side processing requires the effort and the knowledge of a web programmer.

In the proposed solution, the web programmer developed *Java servlet* and *JSP* for server side processing. *Java* technology is employed here because of its wealth of APIs that make the development much easier, thus shorten the development time. Besides the ease of development, the *JSP* that is an extension from servlet technology, introduces a new technique of web site development. Basically, Web site development can be divided into two parts, which are the web pages design and the server side processing. The new technique is called a "*JSP – Servlet – JSP*" model. Figure 2 illustrats the *Java servlet* and *JSP* model.

With *Java servlet* and *JSP* model, programmer and web page designer can work concurrently. This is made possible by using *Bean*, a java object. The programmer and web page designer first, must agree on what data should be passed to one another and this is accomplished by using the *Bean* object. Concurrent development will not lessen the total manpower used but it can push the system into production earlier and thus beginning to earn early profit.

4.2 Security of the System

The success of an e-commerce web site depends very much on users' confidence in doing transaction with it. Therefore the security measure of the e-commerce web site is very important. The Web site must be functioning at all times and sensitive customers information must be protected from preying eyes because denial of services and lack of confidentiality may result in loosing customer's confident of that organization. For this reason, the developed system uses firewall as well as the HTTPS to secure the Web site and the online transaction. In addition to this, Web page that contain certain sensitive information disallow for caching to prevent others from accessing that particular Web page from the computer used during purchasing transaction.
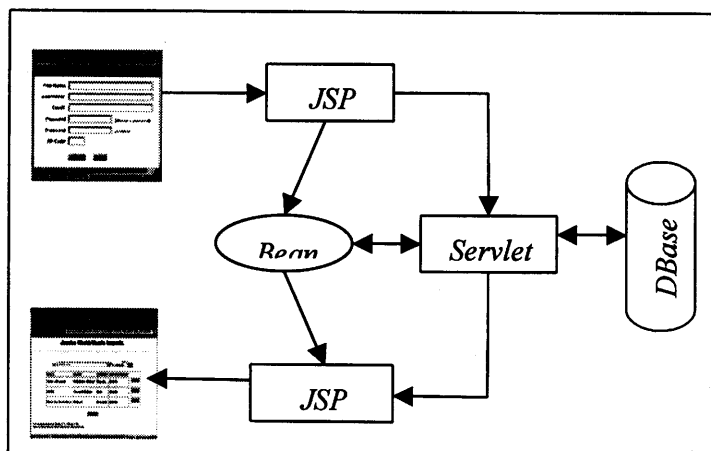

Figure 2: *JSP – Servlet – JSP* Model

4.2.1 Backing off Intrusion with Firewall

Internet firewall is a mechanism in the arsenal of security tools available to network administrators to protect sites against attacks from the Internet. It is highly recommended that organizations use firewall technology to filter connections and limit access.

An Internet firewall provides protection to an organization by implementing a security policy that prevents unauthorized access to the computing resources of its private network. The Internet firewall can be a single system or a group of systems that enforce a security policy between an organization's internal network and the Internet. The firewall decides which internal services can be accessed from outside the network and which outside services can be accessed from within the network.

One of the most significant benefits of having a firewall is that all access to the Internet is managed on the firewall machine. Securing one firewall machine and instituting a well-defined security policy guarantees the security of the internal network. If there were no firewall, all the internal hosts would be subject to attacks and any single host with some vulnerability would compromise the security of the entire internal network.

Many different firewall technologies are in use today. Packet filtering, proxy serving and IP masquerading are among the technologies that can be combined to build effective firewalls on Linux systems that can match with other expensive commercial firewall systems both in performance and in features.

Packet filtering is a process in which each datagram, or packet of data, routed through the router is examined against a set of rules. The filtering rules are based on packet header information, which is available to the IP forwarding process of the kernel. The IP packet header provides the information that is used to permit or deny a packet from being forwarded to its destination interface. Proxy servers are used primarily to monitor and control outbound traffic whereas IP masquerading allows all internal machines to hide behind the firewall machine and use its IP address to access the Internet.

4.2.2 *HTTPS* Protocol to Pass Sensitive Data

E-commerce is doing business online, over the open network such as the Internet. Real time transaction requires sensitive data, like credit card number, to be sent from the client to the e-commerce web site. Anyone connected to the Internet and sit between the two transaction parties, will be able to get those sensitive data easily.

In order to secure the sending of sensitive data through open network, e-commerce Web site should implement *HTTPS* protocol whenever needed. *HTTPS* protocol, using public key cryptography and currently supports up to 128-bit key length, has proven to be a reliable implementation of securing sensitive data through open network.

4.2 Disabling Cache for Sensitive Data on Browser

In order to prevent the browser from caching sensitive data, the e-commerce Web site should be able to tell the browser not to cache the particular Web pages that being sent. Using *HTTPS* protocol can solve the problem whereby pages that contain sensitive data are prevented from caching. To achieve this, the e-commerce Web site system should send

special headers telling the browser, not to cache the web pages with those headers. The example coding that can be used in *JSP* is as follows:

```
<% response.setHeader("Cache-Control","no-cache"); //http 1.1
   response.setHeader("Pragma","no-cache"); //http1.0
   response.setDateHeader("Expires",0);
%>
```

5.0   Analysis and Results

The prototype system was developed on Pentium 233 MMX with 32 MB SDRAM. As for the programming language, JAVA language was selected for coding the software. The finish product provides all the basic services that are required by any e-commerce system. Certain performance aspects have been set when designing the prototype that include:

i.   Scalability – the Web page should be able to respond to a large number of requests without degrading the overall system performance. Using a high-end hardware product can ensure the stability performance of the system.
ii.   Access time and technique – Web page must be small so as to reduce the loading time. This is achieved by Java script.
iii.   No memory leak that can cause the system to crash. Java provides garbage collection mechanism to prevent any memory leakage.

5.1   System Analysis

The system provides on-line catalogue that contains pictures as well as information of the products on sale. To facilitate easy purchasing transaction for the customer, the system integrates an effective shopping cart application with product databases. To purchase any product, the customers will only need to flag the products during the browsing session and it will be added to the electronic shopping cart. At any instance the customer can review the contents of the cart as they browse through the site.

At the end of shopping session, the customers can checkout through the checkout Web page. At this stage the customers is presented with a list of marked goods from the shopping cart, delivery cost and the total cost. The customer can then add shipping instructions, name, address and so on. As for the payment, the system uses the popular payment mechanism that is payment by credit card. To secure the sensitive data such as credit card number, name on the card and expiry date, the system apply HTTPS protocol to encrypt the information before transferring through the Internet. Figure 3, 4 and 5 are some of the examples of the designed Web site.

The management of the databases is not through the Internet because of security measures. The databases are provided with user-friendly graphical user interface that can ease the merchant to update the data or upload product file data. Figure 6 shows one of the examples of the system database graphical interface.
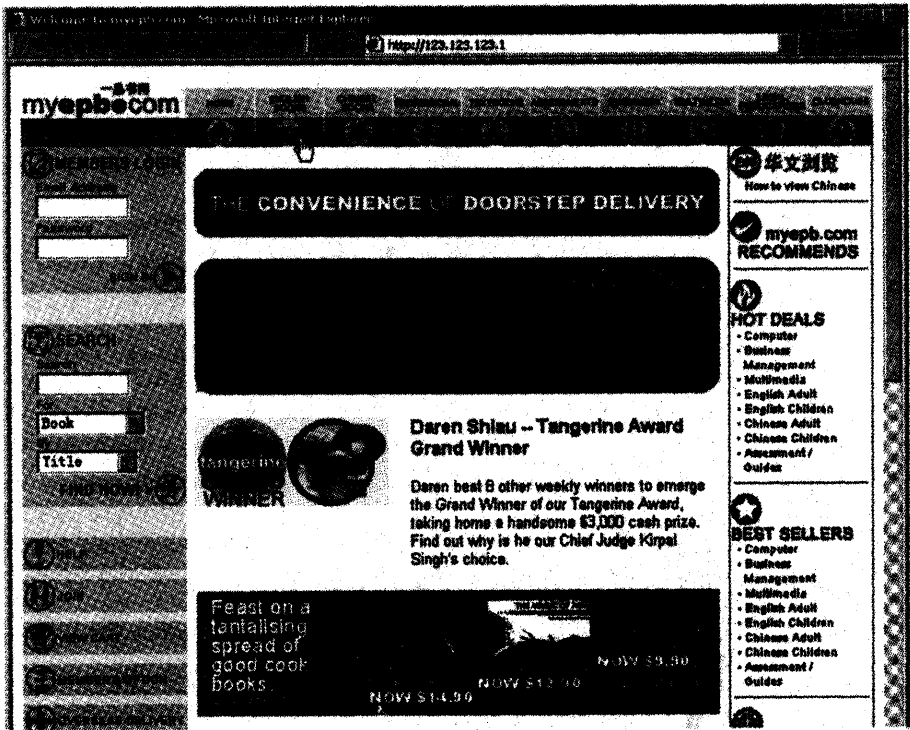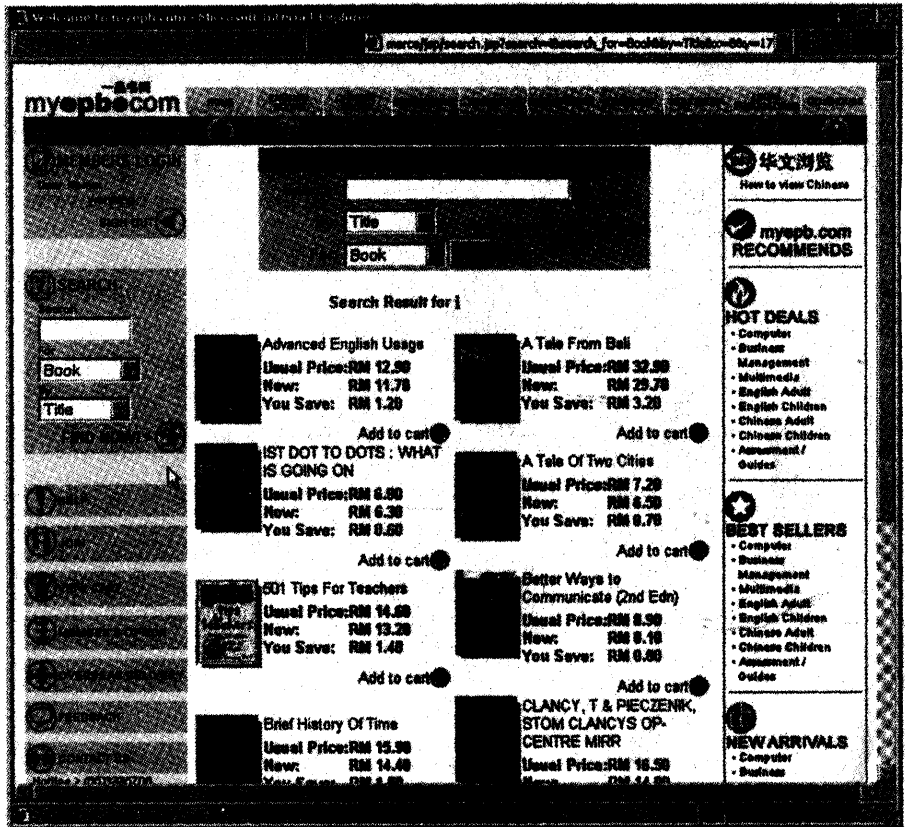
Figure 3: Main Web Page
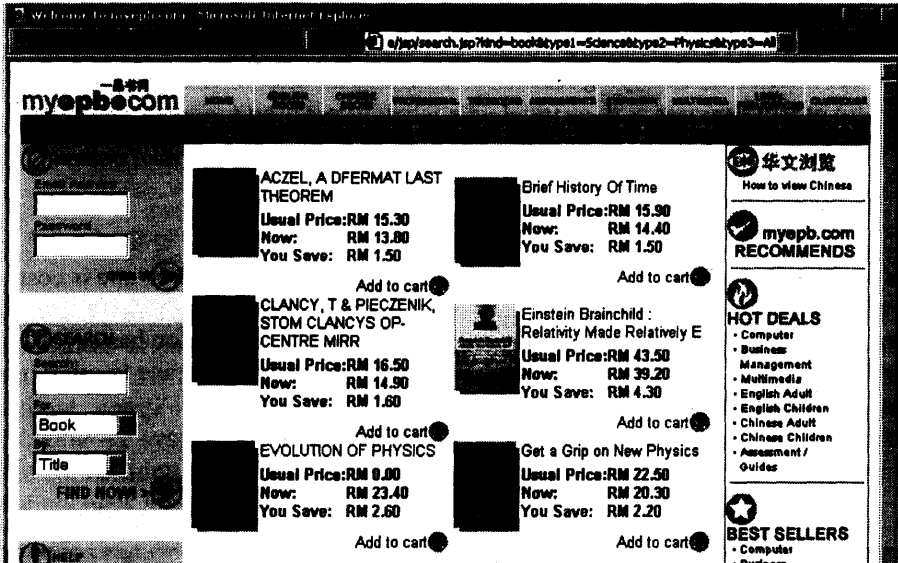

Figure 4: Search Page

Figure 5: Product's Catalog

Figure 6: System Database

5.2 Functional Analysis

Besides assuring that the system components run as it should, the system also need to be ensure that it will function under all circumstances. First of all, the system must be independent of the type of browser used to access the web page. To achieve this, the web page developed only used standard tags. Secondly, all the *Javascript* that is implemented has

been tested and modified so that they will function on both popular used browsers that are Internet Explorer (IE) and Netscape. All the graphical user interfaces as well as the server's processes are tested with satisfying result.

5.3   Implementation Cost

In order to show that the proposed system of building an e-commerce Web site is cost effective, we compare the software costing of our system solution with the *Microsoft* solution as shown in Table 2 and Table 3. From these tables, the proposed solution has saved up to over RM10,000. The prototype system can be easily expanded and upgrade to other high end *Unix* variance like *Sun Solaris* since it's operating system is LINUX.

Table 2: Software costing using *Microsoft* solution

Software		
i.	*OS Windows 2000*	RM 4556.20
ii.	*Internet Information System (IIS)*	(comes with *Windows 2000*)
iii.	*SQL Server 2000*	RM 5658.20

Table 3: Software costing using the proposed solution

Software		
i.	*Linux* operating system	RM 0.00
ii.	*Apache* web server	RM 0.00
iii.	*Jakarta-Tomcat* application server	RM 0.00
iv.	*Sendmail* mail server	RM 0.00
v.	*MySQL* DBMS	RM 0.00
vi.	*PostgreSQL* DMBS	RM 0.00

5.4   Limitation and Drawback

Most shareware tools provide no warranty by the developer for its usage unlike commercial products. Besides supplying the source code for each of the GNU tools, through the Internet, there is no other technical support from the organization that developed the tool. In addition there is no usability warranty for GNU products. Therefore it is under these circumstances that bring the challenge of the research to integrate all of the tools to form a functional e-

commerce Web based product. Due to this the learning curve for GNU products are high comparing if we used commercial products.

The system has not been tested under a high traffic. It is assumed that to tolerate high traffic demand, the hardware used such as memory and processors need to be upgraded.

6.0   Conclusion

Electronic commerce is a new form of marketing that will continue to grow and expand among business organization over the next few years. The marketing approach is new and different. This paper gives an overview implementation of a cost-effective e-commerce web site without compromise the quality and security measures. To reduce the cost of implementing the system, the tools that are employed in the system are free software that is available on the Internet. This paper also gives some guidelines for technical requirements as well as guidelines for creating a successful site.

Nevertheless, many small businesses do not take advantage of the opportunities that the Internet presents. They lack an understanding of its potential benefits, of how to develop electronic commerce profitably or how to cope with the complexity of rules affecting electronic commerce. In addition, many lack the technical personnel that could assist them in implementing a business model for electronic commerce [10].

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