Faculty Of Computer Science And Information Technology

University Of Malaya

WXES 3182

Projek Ilmiah Tahap Akhir II

PAKEJ PENGARANGAN KERTAS SOALAN

EXAMINATION PAPER AUTHORING PACKAGE

EPAP

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ABSTRACT

The Examination Paper Authoring Package (EPAP) is a web-based system that helps teachers and lectures in colleges and universities to create examination papers online. The EPAP provides faster efficient, and yet secure way of examination papers creation that will reduce the lecturer's workload.

EPAP provides three question types such as multiple choice question, structured question and essay question that enables lecturer to create questions easily. It also allows for the questions maintenance in which lecturer is allowed to edit the questions. The EPAP will organize the papers to be printed out for publishing purpose.

Guided by the Waterfall with Prototyping model methodology, EPAP will be developed phase by phase together with the iterative prototyping to meet the user requirements. The EPAP will be developed on the multi-tier client/server, using ColdFusion technology and the ColdFusion Markup Language together with HTML, Javascripts. Microsoft SQL server will serves as database server in the EPAP that provide secure storage for the examination papers.

The EPAP will be built within the limitation boundaries of the project. The constraints that limit the EPAP are stated in the project limitation. There are suggestions for future enhancements for the EPAP that will certainly result in better user experiences. However, during the course of the EPAP development, continuous efforts will be put in to fulfill the user requirements.

ACKNOWLEDGEMENT

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CHAPTER 1 INTRODUCTION

1.1 Project Overview

The evolution of the information technology in the 21st century has brought significant changes in all aspect in our lives. We are now living in a computerized world where most of our jobs are done easily, quickly, with the convenience that information technology brings to us. Governed by the paperless E-government, making transaction through computer system or online with banks and other merchants and now that we are educated with the many sophisticated tools using latest technology.

The information technology has changes the way of education being carried out. Teachers are able enhance customary "chalk and talk" lectures through the use of rich multimedia and interactive content from the computer. This makes the lectures more interesting while improving the understanding of the students with the video and graphical presentation by the computers. To the lecturers or teachers, the advantages of the IT in the education is not just improving the performances of the students, but also making their job easier.

Teachers are obligated with great responsibilities to educate students and to take care of students. Thus they are always busy with massive workload. They have to prepare for lessons, marking assignments and preparing examination papers. In order to reduce the teacher's workload, it inspires the idea of creating a tool to help the teachers in the preparation of examination papers by making it easier and faster.

In this WXES 3181 project, the focus will be on the development of a system that acts as an examination paper authoring tool for teachers or lecturers. The system will allow teacher to create the examination questions with the question template. They may choose to create different kind of question type such as multiple options and subjective questions. The system will then create a standard layout of the examination papers. This eliminates the need to adjust each question manually which in fact the major headache of most of the teachers.

The EPAP system will help teachers to set up examination in a more organized way. Teachers will benefit from using this examination tool, specially in saving time, and easier job.

1.2 Statements Of Problems

About ten years back or may be earlier, when it came to the examinations season, teachers were start busying in preparation of the examination question papers. They will first draft it on papers, and then copy it on a kind of stencil papers. A teacher will keep a copy of his papers, and the less were then sent to printing room to be printed into hundreds copies for students.

The traditional way of creating examination papers were no longer in use because of its weaknesses. The major problems and disadvantages of using the traditional way are :-

1) **Time – consuming**

   Teachers have to write the draft down first, then copy it once again on the stencil papers. Handwriting work is usually consume much time.

2) **More works**

   Teachers have to write the question out and then copy it again. It is tiring if there are many questions.

3) **Difficult to make changes**

   Once the question is already written on the stencil, it is very troublesome to make any changes because a special correction liquid has to be used in order to do so.

4) Tidiness issues

Different teacher will have different style of handwriting. Some of the teachers may have handwriting which is difficult to read. Therefore the examination papers are often not standardized in terms of style and format.

Nowadays, with the advance of technology, teachers have turn to computer to help them create examination papers. It is learnt that most teachers or instructors in the country now are using editor programs to create examination and test papers. Microsoft Word is among the most popular tools. Microsoft Word provides all the tools needed for any documentation that benefits not just office users but the teachers as well.

However, it is not a customized product that tailored for teachers. Teachers have to be familiar with the Microsoft Word before they can create a rather good question papers with properly designed layout or with desired format.

Currently, there is still difficult to find such a teacher tool or similar product which helps to create questions papers in the local market. As such, it is seen as a good opportunity to develop a system to help teacher towards creating question papers with better quality.

1.3 Project Objectives

The main objectives of the Examination Papers Authoring Package are stated as follows :-

- To improve the papers overall layout and subsequently helps to increase the quality of the examination papers.
- To produce standardized examination papers.
- To provide a virtual storage for the examination papers.
- To reduce the teachers or instructors' workload in preparing the examination papers by automating the papers organization.
- To speed up the preparation processes of the question papers.
- To provide a user-friendly system which could help to improve the efficiency of the overall examination system.
- To let teachers create examination papers anytime, anywhere in the web-based environment.

1.4 Project Scope

The Examination Authoring Package will be divided into 4 main sections. Each of these sections is inter-related and is integrated as a whole complete system. These sections include :-

1) User Login and Registration Interface Section
2) Database Section
3) Exam Editor Section
4) Printing Hall Section.

1) User Login and Registration Interface Section

In this section, valid users are allowed to enter into the system with authentication of password. Those who register are valid users. In registration, user information including password will be captured and stored. The registration will enable the user to use the service in the package. They can create, edit and print question papers once they have access the system.

2) Database Section

Database is the core engine that will make the whole system run. It serves as repository which store the information in the system. This section is constructed by a collection of databases of the system. These relational databases are integrated to make the system functionalities executable and feasible. These databases include the teacher or user profile database, the examination question databases for different subject.

3) *Exam Editor Section*

This is the most important feature of the system. This section is developed to allow user to create examination questions, to edit and delete them and to save them. User may choose to create the type of questions they want, for instance, multiple choices questions and others that are available. The system will generate the template of the question type in which the user selected.

4) ***Printing Hall Section***

Once the user has created the question paper and save it into the database. The section of Printing Hall will print the question paper out with properly arranged and organized format.

1.5 Project Limitation

Due to the time and resources constraints, it is regretful that the Examination Authoring Package is limited in certain areas that restrict its ability to fully performs a complete system that meet all requirements. The project limitation are identified in several areas :-

1) Language supports

   The system is using English as its main language. However, teachers can create papers in Malay language also because database allows alphabetical characters data type. Any other data type is not supportable by the database. As such, the Examination Authoring Package cannot support Chinese and Tamil languages.

2) Length of questions

   The DBMS of SQL has maximum length for text field. As such, users are limited in creating questions with characters more than the maximum amount allowed by the database.

3) No drawing tools

   The system has no drawing function, so teachers have to use existing graphics as material.

1.6 Expected Outcome

The Examination Papers Authoring Tools shall bring the following outcomes as expected upon completion.

1) User registration
   - allow user to register so that they can login to the system as valid user.
   - store user's information.
2) User verification
   - verify valid user and allow valid user to enter into the system.
3) Examination question creation and storage
   - allow creation, edit and deletion of questions, stores or saves the examination questions into specific database.
4) Examination papers creation
   - compile the questions into a set of examination paper.
5) Examination papers printing
   - print the examination papers out in organized layout.

1.7 Project Schedule

The project is done in different phases. The duration of each phase is scheduled as stated in the table below.

Table 1.1 Project Schedule

	Task Name	Duration	Start	Finish
1	Problem Analysis	7 days	Mon 6/30/03	Sun 7/6/03
2	Literature Review	14 days	Thu 7/3/03	Wed 7/16/03
3	System Analysis	28 days	Thu 7/17/03	Wed 8/13/03
4	System Design	25 days	Thu 8/14/03	Sun 9/7/03
5	System Protoyping	50 days	Mon 11/10/03	Mon 12/29/03
6	System Construction And Coding	60 days	Mon 11/10/03	Mon 1/12/04
7	System Testing	14 days	Tue 1/13/04	Fri 1/30/04
8	Documentation	204 days	Thu 7/3/03	Fri 1/30/04

Below is the Gantt Chart of the whole project schedule.

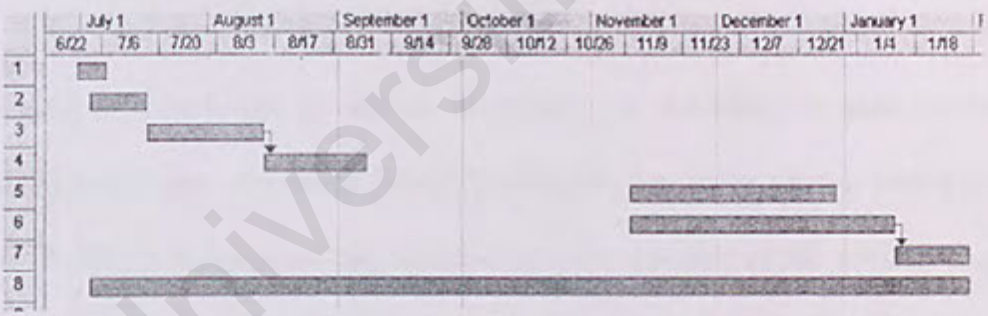


Figure 1.1 Project Schedule Gantt Chart

CHAPTER 2 LITERATURE REVIEW

2.1 Examination – The Definition

According to the Oxford Advanced Learner's Dictionary (3rd Edition), the word examination is grouped into uncountable noun and countable noun with different meanings :-

1) For uncountable noun, it means examine or being examined.
2) For countable noun, it is an instance of examine or being examined, especially :-
   i) A testing of knowledge or ability.
   ii) An enquiry into or inspection of something.
   iii) A questioning by a lawyer in a law court.

In the case of this project that is going to be developed, examination is defined as a testing of knowledge or ability. Generally, an examination aims to evaluate candidate's proficiency in certain field. Examination can be in various forms to test a person's ability. It depends on the objective and the purpose of the testing. Examiner also plays an important role in determining what kind of examination, and how the examination should be held. In general, there are two types of examination, namely literal examination which requires candidate to answer a set of questions on the paper, and practical examination where candidate have to perform or act out physically for their province of study. For the scope of this project, only literal examination is discussed.

2.1.1 Examination Level And Question Types

Depends on a country education system, each level of study will have different examinations at different stage. In the Malaysia education context, there will be monthly test, mid- year examination and final examination each year in primary schools and secondary schools. Besides, there are important examinations in which a student must pass in order to move along for higher level of education such as UPSR in standard six, PMR in form three, SPM in form five and STPM in form six. As for colleges and universities with semester system, mid-semester examination and final examination every semester. This generally described how the examination system in the higher education. It is up to the instructors and lecturers to have additional quizzes and tests on their own initiative and decisions.

The types of the examination papers can be categorized as quiz, test and examination. It is the content of the examination papers that differentiate them from others. A quiz is a short test with only a few questions, while a test may have more questions with more topics covered. An examination is a comprehensive set of questions, covers all topics in syllabus. In examination, candidates will be tested in different types of question to assess their understanding and knowledge in the related field.

There are many ways that a candidate can be tested. Examination questions are designed in several types such as :-

i) Multiple choices questions

ii) True or false questions

iii) Fill in the blank

iv) Match list

v) Subjective / Structured questions

vi) Essays

A teacher or examiner who set the examination papers put a lot of efforts and thought in designing the questions to ensure the quality of the examination. As such an examination papers authoring package is essential in helping them to design better examination paper. It helps the teachers and lecturers to create question papers in an easier and faster way that will certainly reduce their workload.

2.2 Review Of Existing Systems

There are several examination authoring systems available in the market currently. These softwares are mainly targeted at foreign segmentation.

2.2.1 Exam Builder (http://www.exambuilder.com)

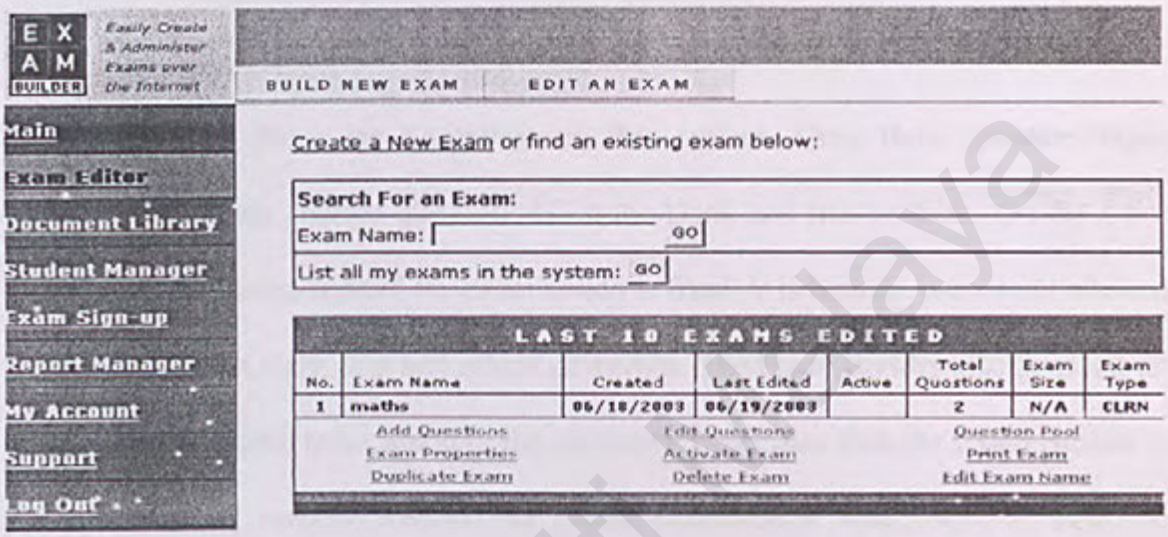


Figure 2.1 Exam Builder – Exam Editor

Developed using ColdFusion technology, the Exam Builder is a web-based solution for both the teachers and students. It provides the teachers solution to easily create and administer examination over the Internet. As teachers login to the exam builder, they will be provided with 6 modules namely, Exam Editor, Document Library, Student Manager, Exam Sign-up, Report Manager, My Account and Support.

The Exam Builder has the powerful exam editor which allow the user to create new examination, edit existing examination. Questions can be added edited and deleted easily. The strongest point is the Question Pool. This feature allows teacher to 'recycle'

or refer to the past questions. The duplication of the examination is enabled and the examination can be activated after the examination is created. The examination activation and examination sign up feature have contribute to the integration of the online examination system where the information is updated and will be used in the online examination system provided to students as they login to sit for examination. At the end of the creation of the examination, teachers can print out the examination.

However, there are limitations in this system. Only three question types available : multiple choices question, fill-in-the-blank and true or false. On the other hand, the presentation style of the examination is fixed. It is because user is not allowed to change the font style, size and others properties. The Exam Builder also does not let the picture or graphic to be added to the questions. Other than that, the Exam Builder is seen as a rather suitable solution for online examination which benefits both the teachers and the students or candidates.

2.2.2 ExamPro (http://www.exampro.uk)

ExamPro combines the popular software engine that Testbase uses with thousands of actual past examination questions from three UK awarding bodies. Tailored for the education system in UK, the package is customized to be distributed by different modules or package by subjects. ExamPro is said to be the essential assessment tool for all GCSE and AS/A2 teachers of mathematics and the sciences. It also supports psychology, business studies and IT at post-16.

All its materials are linked to the latest specification ensuring the most up-to-date analysis for teachers.

i) Create & print customized tests in minutes.

ii) Automatic mark schemes.

iii) Easy-to-use question finder.

iv) Search by topic, unit, specification, type or level.

v) Examiner comments on individual questions.

vi) Export to Microsoft Word facility.

The ExamPro does not provide any types of questions for teachers to choose from. Teachers are not provided with any template for different types. As such, teachers have more flexibility to design their questions, but it will therefore cause the time consuming problem because the creation of question may be slow down. The package has more functionality, specially the export ability. However, it is not user friendly enough, in which user may need time to explore the system before they are familiar with it.

2.2.3 Test Generator II (http://www.testshop.com)

Test Generator is a Windows-based product that enables teachers, trainers, managers, anyone to construct tests.

Test Generator simplifies the entire testing process:

i) Writing questions and answers, administering and scoring tests, and compiling the results.

ii) Tests are password-protected.

iii) Test questions and answers can be randomized and selected from a question bank. The program also features the Test Generator Question Bank - a top-level storage and organizational structure.

iv) Administrators can view the test takers' records, create classes, manage information and generate reports based on individual takers, tests, questions, subjects, and so on. Administrators can also create Instructors and determine their permissions in the program.

v) Tests can be taken on a single machine or over a network.

Test Generator is advance in bring even more functionalities and tools for better question designing experience. Teachers are able to create better quality examination papers with less restriction from the system. The software provides formatting tools to let the user to change the fonts, adjust the alignment and others formatting that any text editor will provide. Besides, Test Generator also allow user to insert picture, media.

The process of generating questions has some drawbacks in which the user is required to set the answer setting separately. If there is a missing information, user can not save the question. Although it has the advantage to ensure the correctness and the completeness of the question, the process flow may be slow down at the same time.

2.3 Development Platform And Supporting Technologies

2.3.1 Development Platform

A platform is the underlying hardware and softwares for a system in traditional computing environment. A platform defines a standard around which a system can be developed. Two successive and popular platforms that have dominated the computing industry nowadays are client/server platform and World Wide Web platform.

2.3.1.1 Client/Server platform

The client/server platform is a network architecture in which each computer on the network is either a client or a server. Severs are powerful computer dedicated to managing disk drive (file servers), network traffic (network servers) or application. Client carries a substantial part of the processing. The software functions are divided into applications, database, interface logic, and interface.

Basic client-server architecture allows a client to send a request to a server through a query, thereby reducing network traffic. The server then queues and processes the request by interpreting; analyzing and "serving up" the information back to the client. The client application then has the ability to present this information to the user via a graphical user interface or if it is preferred, through a host terminal. This process allows for a multi-user environment using a shared data source.

In extension to the thin- client system, the server's responsibilities are separated into two or more tiers.

2.3.1.1.1 Client Server 2-tier

The 2-tier architecture generally describes a client-server environment with additional processing being provided by a database-management server. The main advantage of this set-up is that heavy processing on the client side is minimized and therefore, less client-side software is required. In this case, since many changes are made on the server itself, costly deployment costs can be avoided, especially in a larger organization.

2.3.1.1.2 Client Server multi-tier

In multi-tier system, the first level server executes the applications and the second level server executes the database. With this architecture, often called the 3-tier architecture, processing can be centralized in at the middle tier. In larger enterprise level environments, many database servers may be storing information for a variety of application and business requirements. In these environments, the middle tier will easily support each different database server by using shared and reusable rules and models. These rules can be changed from a central location, providing standardization and organization for the corporation.

2.3.1.2 World Wide Web Platform

The World Wide Web (WWW) Platform is a subset of the wide area network. The WWW is vast distributed system comprised of millions or servers where information is stored across many computers and shared through a network supporting

the TCP/IP suite of protocols. Web pages are sent over the Internet from Web servers to the browser.

The WWW is also a multi-tier distributed client/server system where the browser on personal computers acts as clients and served by the Web servers.

In the next section, the discussion will focus on different kind of servers and browsers at the client side.

2.3.2 Web Servers

Web server is a computer and associated software that is attached full time to the Internet. A server consist of :-

1) Hardware, which could be a personal computer, workstation, or a mainframe computer.
2) An operating system such as Windows NT, UNIX, or some mainframe operating system such as MVS and VMS that runs on the hardware.
3) The Web server software, which runs on top of the operating system.

To choose a Web server, attributes such as performance, security, interface to back end, publishing capability, management and administration should be taken into consideration.

2.3.2.1 Microsoft Personal Web Server (PWS)

Running on Microsoft Windows 95 or 98, Personal Web Server is designed for personal use to set up Web sites for corporate workgroup or staging personal Web site. PWS runs quickly. It can be used to host a Web site on personal computer at home or as part of an intranet at work, or to develop and test a Web site before hosting the site with an Internet Service Provider (ISP). It is suitable for simple and rapid prototyping under Windows 95 and 98.

2.3.2.2 Microsoft Internet Information Server (IIS)

Microsoft Internet Information Server is intended to run on a single platform (e.g., Intel compatible processors and the Windows NT OS). Managed from the Microsoft management Console, IIS has gain popularity the as a result of the ease of use.

With superior performance across the board, IIS can almost always serve up pages faster than Netscape Enterprise Server or Apache Server. IIS on Windows NT 4 ISAPI outperformed the competition, with more than 2000 requests per second for simple dynamic comparisons and only slightly fewer for e-commerce dynamic comparisons. These measures, performed on a single server, bode well for the future of this solution, given that some of the alternatives, including Stronghold on Solaris and Sun Web Server (SWS) on Solaris, had fewer than 500 requests per second.

2.3.2.3 Apache Web Server

The Apache server is available on many platforms in both binary and source code format. It has earned the reputation of being the most reliable Web server ever. Apache gains widespread acceptance as a result of its overall stability. Besides, it is also relatively fast.

As an open-source Web server, Apache Server has many user contributions available in the form of server modules and commercial distributions. The server gets a growing number from numerous initiatives such as Jakarta, tomcat, XML-Apache,

Java-Apache and so-on. With the mod Perl, mod PHP, and XML scripting ability, Apache will reach a level of functionality that others will have difficulty matching.

Apache Server's greatest strengths are its huge amount of end-user support, nearly universal platform support, and rapid bug fixes and product cycles. Although not as robust and feature-rich as Netscape's or Microsoft's offerings, Apache Server does fit the bill for a large number of configurations, and it's free.

2.3.2.4 IPlanet Enterprise Server

With the Netscape Enterprise administrative console, Netscape Communications' IPlanet enterprise Server is the easiest server to use, manage and configure. With its support for Solaris and Windows NT, this solution will work with most enterprise-class hardware available today. This stable server seldom requires rebooting and does not have system failures apart from potential hardware problems.

The Enterprise Server's performance stayed on par with Internet Information Server (IIS) for the Intel platform, and consistently outdid Apache Server in dynamic tests. The server can be configured with through editing of the configuration text file. The Web User Interface can be used to set up the server. Furthermore, the inexperienced user is supported by the well designed context-sensitive online help.

2.3.3 Application Server

An application server is a server program in a computer in a distributed network that provides the business logic for an application program. There is no clear consensus as to what an application server is, but the software category is an extension of a middleware. An application server is designed to isolate the business logic as well as to develop multi-tier applications with flexible connections.

The application server is frequently viewed as part of a three-tier application, consisting of a graphical user interface (GUI) server, an application (business logic) server, and a database and transaction server. More descriptively, it can be viewed as dividing an application into:

1) A first-tier, front-end, Web browser-based graphical user interface, usually at a personal computer or workstation.
2) A middle-tier business logic application or set of applications, possibly on a local area network or intranet server.
3) A third-tier, back-end, database and transaction server, sometimes on a mainframe or large server

2.3.3.1 Sun ONE Application Server

The Sun ONE Application Server 7 provides a Java 2 Platform, Enterprise Edition (J2EE platform) 1.3 compatible platform for developing and delivering Java web services. It integrates a powerful application development environment with the Sun ONE Studio 4, that increases developer productivity and speeds overall time to

market. Available in three editions, each designed to provide specific functionality for different usage scenarios and service levels, the Sun ONE Application Server delivers end-to-end high performance across a broad range of Web and enterprise application requirements.

The Sun ONE Application Server 7 is an new architecture based on the J2EE Reference Implementation, along with the Java Web Services Developer Pack (Java WSDP), both from Sun Microsystems. It is free for development and deployment on the Sun ONE Application Server 7, Platform Edition, and free for development and evaluation on the Sun ONE Application Server 7, Standard Edition, providing a low total-cost-of-ownership for the J2EE platform.

2.3.3.2 Oracle Application Server

Oracle application server is well integrated with the Oracle DBMS and other Oracle development tools, including JDeveloper, a Java-intergrated environment. Oracle WebDB is an associated product that allows the development of a website with the help of a set of wizards. Oracle also support the XML interoperation solutions in its latest version tools, Oracle9i.

2.3.3.3 Macromedia ColdFusion Application Server

Macromedia Servers like ColdFusion MX and JRun empower developers to rapidly deliver applications that enable communications, collaboration, commerce and automate business processes. ColdFusion Markup Language (CFML) is the standard for

efficient and approachable development, while JRun delivers scalable, Java-based applications in an open, J2EE standards environment. While Macromedia ColdFusion MX combines an intuitive, tag-based language, rich, visual tools, and a proven, reliable Web application server provides fastest way to build and deploy powerful Web applications.

One of the key components of the Macromedia is the ColdFusion server which combines an open, extensible architecture that integrates easily with existing systems as well as built-in application and infrastructure services. ColdFusion MX also provides development tools that supports a powerful, easy to learn server-side scripting language, ColdFusion Markup Language (CFML). It cleanly integrates with all popular Web languages and technologies. Besides, ColdFusion works with multi-tier architectures through COM, CORBA, and EJB integration. It can also be easily extended with new components created with Java Servlets, Java classes, or C/C++. And thousands of third-party components are available in the Developers Exchange.

ColdFusion uses ODBC Connections. It can access standard ODBC-compliant desktop relational databases including Microsoft Access and FoxPro, Borland Paradox and dBase, Lotus Approach, text files, and Excel files with a single tag. SQL is used to select, insert, update, or delete data. Dynamic SQL is built based on variables and application logic. ColdFusion outputs database queries with a single tag. It can easily generate HTML tables with database output.

2.3.4 Web Browser

The material distributed on the Internet is displayed with a heterogeneous set of browsers. Web browser is a client program which enables the client machine to interact with the server.

2.3.4.1 Internet Explorer (IE)

The desktop market is currently dominated by Internet Explorer and Netscape Communicator. IE's extended features and its closer integration with the desktop operating system have accelerated the dominance of Microsoft. While retaining the features of IE 5.5, IE 6.0 adds more features :-

i) Tools to Protect Privacy that support the platform for Privacy Preferences (P3P).

ii) Enables users to extract information about an Internet Explorer problem and upload the data to Microsoft for analysis. This has greatly improves the reliability with the fault collection.

iii) Includes support for Microsoft XML (MSXML) 3.0, providing better performance and up-to-date XML standards support.

iv) Provides DHTML features to build a powerful user interface for Web based applications.

v) As part of the WebService behavior, makes integration of server and client side code easier, and enables applications to call functions on the server asynchronously in .NET framework.

2.3.4.2 Netscape Communicator

Netscape Communicator in its latest version, 7.1 has offered the some features to compete with IE. Among them is the ability to browse multiple Web sites in a single window, letting user avoid the necessity of continually pressing Alt-Tab when comparison shopping. It also features tabbed browsing, user can keep track of sites in the same window. The browser has a Quick Launch feature, enabling user to get online faster. Furthermore it allows multiple files download at once, and resume download if Internet connection is interrupted.

Netscape 7.1 includes a browser (Netscape Communicator), an e-mail client, an address book, and a Web page editor. In this latest version, the folks at Netscape are also bundling AOL Instant Messenger and a radio station (Radio@Netscape).

Netscape's browser includes a "Master Password" that prevents people who have access to the user personal computer from using his or her passwords. User can also selectively block cookies from certain Web sites or choose to be alerted when cookies are sent to the PC.

Java is also supported by this free browser. Same as IE, Netscape Communicator comes with its own Java virtual machine. It has also gained better support for the latest standard, including XML.

2.3.4.3 Opera

Opera software offers a refreshing different approach, with a browser optimized fro space and speed. Among Opera notable features are strict adherence to HTM standards, sophisticated and speedy Web browsing with news and e-mail, and secure 128-bit SSl encryption. This selection is ideal for older machine and mobile computing with less available memory or disk space. Opera is available free for download. In addition, he opera also runs as a native 16-bit application under Windows 3.1 and 3.11.

2.4 Softwares and Supporting technologies

2.4.1 Operating System

An operating system (OS) is a group of programs designed to serve two basic purposes :-

- To control the allocation and use of the computing system's resources among the various users and tasks, and.
- To provide an interface between the computer hardware and the programmer that simplifies and makes feasible the creation, coding, debugging, and maintenance of application programs.

It is a low-level software which handles the interface to peripheral hardware, schedules tasks, allocates storage, and presents a default interface to the user when no application program is running. The major operating systems in the computer market are discussed in the next section.

2.4.1.1 Microsoft Windows 98

Windows 98 (called "Memphis" during development) is a widely-installed product in Microsoft's evolution of the Windows operating system for personal computers. Windows 98 expresses Microsoft's belief that users want and should have a global view of their potential resources and that Web technology should be an important part of the user interface.

In Windows 98, Microsoft's Internet Explorer is an integral part of the operating system. Using the Active Desktop of Windows 98, desktop objects that reside on the World Wide Web as well as local files and applications can be view and accessed. The Windows 98 desktop is, in fact, a Web page with HTML links and features that exploit Microsoft's ActiveX control.

With Windows 98, users can set up news and other content to be push technology (Webcasting, prearranged updating of news, weather, or other selected information on a computer user's desktop interface through periodic and generally unobtrusive transmission over the World Wide Web (including the use of the Web protocol on intranet)). to them from specified Web sites.

Windows 98 also provides a 32-bit file allocation table (FAT) that allows user to have a single-partition disk drive larger than 2 Gigabytes. Other features in Windows 98 include:

i) Support for Universal Serial Bus (USB), which makes it easy to plug in new devices.

ii) Support for Digital Versatile Disc (DVD)

iii) Support for a new industry-standard form of power management called Advanced Configuration and Power Interface (ACPI)

2.4.1.2 Microsoft Windows 2000

As Microsoft considered the next step in the evolution of the NT platform, they wanted to create a product that maintained the reliability of NT with some of the flexibility of a consumer OS. The result is the 2000 series of operating systems. Previously called Windows NT 5.0, Microsoft emphasizes that Windows 2000 is evolutionary and "Built on NT Technology."

Windows 2000 is designed to appeal to small business and professional users as well as to the more technical and larger business market for which the NT was designed. Windows 2000 supports a smaller base of hardware and software than Win9x or ME and is focused on doing the important things well rather than trying to do it all.

The Windows 2000 product line consists of four products:

1) **Windows 2000 Professional**, most economical choice for individuals and businesses of all sizes. It includes security and mobile use enhancements.
2) **Windows 2000 Server**, aimed at small-to-medium size businesses. It can function as a Web server and/or a workgroup (or branch office) server. It can be part of a two-way symmetric multiprocessing system.
3) **Windows 2000 Advanced Server**, aimed at being a network operating system server and/or an application server, including those involving large databases. This server facilitates clustering and load-balancing.
4) **Windows 2000 Datacenter Server**, designed for large data warehouses, online transaction processing (OLTP), econometric analysis, and other

applications requiring high-speed computation and large databases. The Datacenter Server supports up to 16-way SMP and up to 64 gigabytes of physical memory.

The key features that make Windows 2000 Server the reliable operating system for workgroups and small businesses include :-

i) **Speed and Reliability**

Windows 2000 is up to 30 percent faster and 13 times more reliable than Windows 98, according to NSTL (National Software Testing Labs) tests due to its more streamlined code. The improved reliability comes from a change in the memory management system, reducing the chance that software applications will interfere with one another. In addition, Windows 2000 includes a built-in safeguard called Windows File Protection. This feature helps prevent critical operating system files from being deleted or altered by users or applications.

ii) **Networking**

Windows 2000 makes it easier to get these networks up and running. The Network Neighborhood folder in Windows NT 4 and Windows 98 has been replaced by My Network Places. A new wizard called Add Network Place makes connecting to network resources, such as shared drives and printers, easier.

iii) **Built for Mobile Users**

Microsoft has added a number of features to Windows 2000 to make it an appealing option for notebook users. Unlike NT, 2000 supports power management on hardware with bios support for ACPI (Advanced Configuration and Power Interface), a power-management specification that lets the PC control power to peripherals. It's a great help to notebook users to be able to control which parts of the computer receive what amount of power. The Synchronization Manager feature (sometimes referred to as "Offline Files and Folders") provides a centralized, standardized way of synchronizing files for offline use. It allows users to update their files for use offline, then, when back online, copies the offline changes back to the network.

iv) **Hardware Support**

Unlike NT, Windows 2000 offers full support for the Plug and Play standard which simplifies the process of adding hardware to PC. Users are allowed to swap devices like digital cameras and printers that connect via USB and Firewire connections without having to reboot. While Windows 2000 supports a large number of products, it's a much smaller number than Windows 9X or ME.

v) **Security**

Windows 2000 has Kerberos support. Kerberos an Internet-standard which makes it especially effective for networks consisting of different operating systems such as UNIX provides industry-standard and high-strength authentication with fast, single logon to Windows 2000-based enterprise resources. The Windows Security Model permits only authenticated users to access system resources. The security model includes components to control who accesses objects (such as files and shared printers), the actions an individual can take on an object, and the events that are audited. Besides, the Encrypting File Systems encrypts each file with a randomly generated key.

2.4.1.3 Microsoft Windows XP

Windows XP Professional integrates the strengths of Windows 2000 Professional, such as standards-based security, manageability, and reliability, with the best business features of Windows 98 and Windows Millennium Edition, such as Plug and Play, simplified user interface, and innovative support services. This combination creates the best desktop operating system for business.

Windows XP adds more features while retaining the features in Windows ME. These features are :-

i) **Efficient and dependable computing**

It is reliable as it is built on the proven code base of Windows NT and Windows 2000, which features a 32-bit computing architecture and a fully protected memory model. Building on the device driver verifier found in Windows 2000, the Windows XP Professional will provide even greater stress tests for device drivers.

ii) **Easy to use**

Windows XP provides an adaptive user environment. It adapts to the way an individual user works. With a redesigned Start menu, the most frequently used applications are shown first. Windows XP also works with rich media. Windows XP has a wide range of entertainment features and multimedia support designed to fully integrate digital media into the PC.

iii) **Advanced Productivity Tools**

The Remote Desktop allows users to create a virtual session onto their desktop computers using the Microsoft Remote Desktop Protocol (RDP). Users can access all of their data and applications housed on their desktop computers from another computer running Windows 95 or later that is connected to their machine via a network. Besides, the Credential Manager, as secured store for password information, allows users to

input user names and passwords once, and then have the system automatically supply that information for subsequent visits.

iv) **Advanced Management, Deployment, and Support Tools**

SysPrep helps administrators clone computer configurations, systems, and applications. A single image, which includes the operating system and business applications, can be restored to multiple different machine configurations.

v) **Multilingual Support**

Allows users to easily create, read, and edit documents in many languages with the English version of Windows XP Professional. The Multilingual User Interface Pack, an add-on pack to the English version of Windows XP Professional, lets user change the user interface language for each user.

2.4.1.4 UNIX

UNIX is a powerful computer operating system originally developed at AT&T Bell Laboratories. It is an operating system written in c language. It is very popular among the scientific, engineering, and academic communities due to its multi-user and multi-tasking environment, flexibility and portability, electronic mail and networking capabilities, and the numerous programming, text processing and scientific utilities available.

Unix's features include :-

i) **Multitasking**

A single computer running the Unix operating system can simultaneously run several independent jobs. Today most operating systems including Windows and the MacOS are multitasking; however, Unix still provides one of the most seamless and stable multitasking environments.

ii) **Multi-user**

Unix organizes multiple tasks from multiple users so that they can run programs and access files at the same time. Different users can even access the same file at the same time.

iii) **Programming Environment**

Unix provides the ultimate in computer programming environments. Powerful C, C++, Fortran and Java compilers along with development tools are available for free. Furthermore, the Internet is littered with libraries of free code for these compilers.

iv) **Free Software**

Because there are several free versions of Unix that provide excellent programming environments, there are literally thousands of free applications available for Unix machines. One of Unix's greatest strength

versus other operating systems is the high quality of its freely available applications.

2.4.1.5 Linux

The seeds for Linux were planted in the late 60's when UNIX OS was created. Created by Linus Torvalds, Linux is a remarkably complete operating system, including a graphical user interface, an X Window System, TCP/IP, the Emacs editor, and other components usually found in a comprehensive Unix system. Unlike Windows and other proprietary systems, Linux is publicly open and extendible by contributors. Because it conforms to the Portable Operating System Interface standard user and programming interfaces, developers can write programs that can be ported to other operating systems. Linux comes in versions for all the major microprocessor platforms including the Intel, PowerPC, Sparc, and Alpha platforms. It's also available on IBM's S/390. Linux is distributed commercially by a number of companies.

Linux has gained popularities due to the following features :-

i) **Cost effective and reliable**

One of the biggest advantages to running a Linux based system is the cost of hardware. Linux requires less system resources to operate smoothly. Linux is Open Source, therefore more secure and reliable.

ii) **The Interface**

In its native form, Linux has a command line interface. The K Desktop Environment (KDE) and Gnome include many of the tools that Windows users are familiar with such as a file manager, a window manager, a help system, a configuration manager and other utilities. Linux also has a mature X Windows GUI interface that is very customizable.

iii) **Software Support**

Corporate support for Linux continues to grow. Companies such as IBM are investing in Linux technology and promoting its strengths in the server market while other companies are creating products that they hope will show prospective users that they can enjoy the flexibility of Linux without giving up the features of the Windows environment. A number of companies are creating Linux compatible versions of desktop publishing, surfing the web and playing games applications.

iv) **Networking protocol support**

Linux has support for almost every networking protocol and suite such as Ethernet, Gigabit Ethernet, FDDI, PPP, DHCP, ATM, Appletalk.

While Linux has grown from an OS that would only be of interest to the most knowledgeable of computer users, it still has a long way to go to reach the level of simplicity and user-friendliness found in the Apple and Microsoft products.

There are different "brands" of Linux, called distributions. Some of the companies that distribute their own brands of Linux are Red Hat, Debian, Caldera Systems, Corel, and Slackware. Red Hat seems to be one of the more popular distributions for home users.

2.4.1.6 Macintosh OS X

Mac OS comes with Apple Computer's iMac and Power Macintosh line of computers. OS X has a modular design intended to make it easier to add new features to the operating system in the future. It runs Unix applications as well as older Mac applications.

Mac OS X provides a luscious, liquid interface, called Aqua, across every application and the utilities user need to control and customize Mac computer. In addition, user can easily connect Mac to any network — whether wired or wireless, Mac-, UNIX- or Windows-based.

OS X offers the following features that improve the user experience :-

i) **Rich digital media**

In OS X, user can listen to music, create movies, DVD and share digital photos.

ii) **Better Internet surfing experience**

Sherlock 3 makes it easy to grasp the information, enabling better web searching.

iii) **Bluetooth support and wireless web**

Auto-configure AirPort and use Mac as a base station enables wireless web surfing. The bluetooth features in OS X can check Caller ID, send files and SMS messages over the industry standard.

In general, Macs are highly popular and almost a cultural necessity among graphic designers and online visual artists.

2.4.2 Programming Languages

A program is a specification of a computation. A programming language is a notation for describing programs (MacLennan, 1987). Often, a program is expressed in a programming language just so that it can be executed on a computer. But this is not the only use of programming languages: they may be used to describe programs to other people; or to ourselves, just as we use mathematical notation; just think of how much of programmers' time is spent reading programs. A programming language is a language that is intended for the expression of computer programs and that is capable of expressing any computer program (MacLennan, 1987).

The review of the operating systems is followed by the programming languages that used to develop programs in the operating system. Below are the common programming languages that has been reviewed.

2.4.2.1 C / C++

C++ is a member of the ALGOL family of programming languages, very much a successor to C, with *classes* from Simula. C++ represents a significant extension of C abilities. C is considered to be a subset of C++. C++ supports essentially every desirable behavior and most of the undesirable ones of its predecessor, but provides general language improvements as well as adding OOP capability.

Because C++ retains C as a subset, it gains many of the attractive features of the C language, such as efficiency, closeness to the machine, and a variety of built-in types.

A number of new features were added to C++ to make the language even more robust, many of which are not used by novice programmers. These features include the role of constants, inline expansion, references, declaration statements, user defined types, overloading, and the free store.

Most of these features can be summarized by two important design goals: strong compiler type checking and a user-extensible language. By enforcing stricter type-checking, the C++ compiler makes us acutely aware of data types in our expressions. Stronger type checking is provided through several mechanisms, including: function argument type checking, conversions, and a few other features we will examine below.

C++ also enables programmers to incorporate new types into the language, through the use of classes. A class is a user-defined type. The compiler can treat new types as if they are one of the built-in types. This is a very powerful feature. In addition, the class provides the mechanism for data abstraction and encapsulation, which are key to object-oriented programming.

2.4.2.2 JAVA

Java was originally developed at Sun Microsystems in 1991 to provide a platform-independent programming language and operating system for consumer electronics (TV sets, toasters and VCRs). In syntax and execution, Java is a lot like a simplified version of C++. It is a highly robust, distributed, high performance, object-oriented, multi-threaded language with all of the usual features.

Java's features include :-

i) **Simple and small**

Java omits many rarely used, poorly understood, confusing features of C++, as a result, it is simple. Java is small and can run stand-alone in small machines.

ii) **Object-oriented and distributed**

Being an object-oriented language, Java has an extensive library of routines for coping with TCP/IP protocols like HTTP and FTP. Java applications can open and access objects across the net via URLs with the same ease as when accessing a local file system.

iii) **Robust and secure**

The Java applications are robust because the Java runtime environment manages memory. The Java runtime environment also has built-in protection against viruses and tampering.

iv) **Portable**

Applications written in Java are portable across multiple platforms. They will run without modification on multiple operating systems and hardware architectures.

v) **Multithreaded and higher performance**

The multiple concurrent threads of activity in Java application are supported by the multithreading built into the Java programming language and runtime platform, giving better interactive responsiveness and real-time behavior.

2.4.2.3 Visual Basic / VB.NET

Visual Basic is a high level programming language evolved from the earlier DOS version called BASIC (Beginners' All purpose Symbolic Instruction Code). IT is a programming environment from Microsoft in which a programmer uses a graphical user interface to choose and modify pre-selected sections of code written in the BASIC programming language.

VB is a VISUAL and events driven Programming Language. In VB, programming is done in a graphical environment. A VB Program is made up of many subprograms, each has its own program codes, and each can be executed independently and at the same time each can be linked together in one way or another.

VB.NET is part of a brand new platform, based on the .NET Framework. All languages in .NET are based on this new platform, which allows many great new capabilities for a VB developer. Because the .NET Framework is fully object-oriented, VB.NET and other .NET languages are fully object-oriented. This is a huge difference

and is a powerful improvement over previous version of VB. It also introduces another level of complexity along with this new power.

The advantages of VB .NET are :-

i) Full object-oriented capabilities.

ii) An incredible IDE.

iii) Cross-language inheritance.

iv) Real VB (or C#, etc) in ASP.NET, not VBScript.

v) Web service tools.

vi) One way to do things, no matter what .NET languages are being used.

2.4.3 Web Programming Languages / Scripting Languages

In this section, the web programming languages and scripting languages are studied. The popular web programming languages that build up the Internet world are identified below.

2.4.3.1 Active Server Pages

An Active Server Page (ASP) is an HTML page that includes one or more scripts (small embedded programs) that are processed on a Microsoft Web server before the page is sent to the user. An ASP is somewhat similar to a server-side include or a common gateway interface (CGI) application in that all involve programs that run on the server, usually tailoring a page for the user. Typically, the script in the Web page at the server uses input received as the result of the user's request for the page to access data from a database and then builds or customizes the page on the fly before sending it to the requestor.

With Active Server Pages, a software developer can create interactive and personalized web pages for their World Wide Web site or corporate intranet without having to understand the internals of a web server or complex application programming interfaces. In addition, Active Server Pages is extensible via software components written using Microsoft's Component Object Model so user will be able to take advantage of code user have already written using languages such as Visual Basic, C++ or Java.

2.4.3.2 PHP

PHP (recursive acronym for "PHP: Hypertext Preprocessor") is a widely-used Open Source general-purpose scripting language that is especially suited for Web development and can be embedded into HTML.

It can be used to manage dynamic content, work with databases, handle session tracking, and even build entire e-commerce sites.

PHP can be used on all major operating systems, including Linux, many Unix variants, Microsoft Windows, Mac OS X, RISC OS, and probably others. PHP has also support for most of the web servers today. This includes Apache, Microsoft Internet Information Server, Personal Web Server, Netscape and iPlanet servers, and many others.

The strong points of the language include its stability, ease of use and the fact that PHP can perform any task a more complex CGI (Common Gate Interface) program would do. CGI is a specification for transferring information between a World Wide Web server and a CGI program which written in any programming language, designed to accept and return data conforms to CGI specification. PHP solved one of the crucial performance problems with CGI by becoming the Web server, saving the end user a considerable amount of load time.

One of the strongest and most significant features in PHP is its support for a wide range of databases, including MySQL, Oracle, Sybase, mSQL, Generic ODBC,

and PostgreSQL. Writing a database-enabled web page is incredibly simple. PHP also has support for talking to other services using protocols such as LDAP, IMAP, SNMP, NNTP, POP3, HTTP, COM (on Windows) and countless others.

2.4.3.3 ColdFusion

Developed by Allaire, ColdFusion consists of a server component that supports proprietary tags in Web pages. ColdFusion Web pages include tags written in Coldfusion Markup Language (CFML) that simplify integration with databases and avoid the use of more complex languages such as C++ to create translating programs.

Developing application with ColdFusion does not require coding in a traditional programming language. Instead, applications are built by combining standard HTML with a straightforward server side markup language, CFML. Coldfusion provides tags, expressions, and functions. CFML provides a number of proprietary tags that can be used to interact with database, send e-mail, build HTML output, and manage files. Look like HTML, CFML tags are preprocessed on the server. Expressions combine data, variables, operators and functions to manipulate data and return a result. Expressions are used for mathematical calculations, string manipulation, date-time operations, and formatting results.

ColdFusion functions are predefined operations that can be used in expression in a variety of places in templates. CFML supports over 130 functions in the following categories :-

i) Mathematical and trigonometric functions.

ii) Bit manipulation functions.

iii) Decision functions.

iv) String functions.

v) Date and time functions.

vi) Administrative functions.

vii) System-level functions.

viii) Date, time and number formatting functions.

ix) List function.

ColdFusion provides a comprehensive set of features that enable:

i) **Rapid development**

The ColdFusion development platform enhances the speed and ease of development through the following features:

- A tag-based server scripting language that is powerful and intuitive.
- Two-way visual programming and database tools.
- Remote interactive debugging for quickly identifying and fixing problems.
- Web application wizards to automate common development tasks.
- Source control integration to enable team development.
- Secure file and database access via HTTP for remote development.

- A tag-based component architecture for flexible code reuse.

ii) **Scalable deployment**

ColdFusion delivers a high-performance platform for application deployment through the following features:

- A multi-threaded service architecture that scales across processors.
- Database connection pooling to optimize database performance.
- Just-in-time page compilation and caching to accelerate page request processing.
- Dynamic load balancing for scalable performance in a cluster environment (Enterprise Edition only).
- Automatic server recovery and fail-over for high availability (Enterprise Edition only).

iii) **Open integration**

ColdFusion integrates with new and legacy technologies through the following features:

- Database connectivity using native database drivers (Enterprise Edition only), ODBC, or OLE-DB.
- Embedded support for full text indexing and searching.

- Standards-based integration with directory, mail, HTTP, FTP, and file servers.
- Connectivity to distributed object technologies including CORBA (Enterprise Edition only), COM (Windows Enterprise Edition only), Java objects and EJBs.
- Open extensibility with C/C++ and Java.

iv) **Complete security**

ColdFusion provides a foundation for building secure applications through the following features:

- Integration with existing authentication systems including Windows NT domain and LDAP directory servers, and proprietary user and group databases.
- Advanced access control so that server administrators can control developers' access to files and data sources.
- Support for existing database security.
- Server sandbox security for protecting multiple applications on a single server (Enterprise Edition only).
- Support for existing Web server authentication, security, and encryption.

2.4.3.4 HTML

HTML (Hypertext Markup Language) is the set of markup symbols or codes inserted in a file intended for display on a World Wide Web browser page. HTML

allows description of the document structure in a way that is portable from one computer to another. The markup tells the Web browser how to display a Web page's words and images for the user. Each individual markup code is referred to as an element (also refer to it as a tag). Some elements come in pairs that indicate when some display effect is to begin and when it is to end.

2.4.3.5 DHTML

Dynamic HTML is defined by W3C as a term used by some vendors to describe the combination of HTML, style sheets and scripts that allows documents to be animated. Dynamic HTML is a combination of technologies to make Web pages dynamic. It is HTML with a few new elements plus access to those elements via a scripting language. The new elements provide precise control over how web page looks and the new object model allows manipulation of those elements programmatically using scripts. Thus, it gives authors the ability to create visually outstanding HTML documents that interact with the user, without the burden of relying on server-side programs or complicated sets of HTML pages to achieve special effects.

2.4.3.6 JavaScript

JavaScript is a scripting language - a scripting language is a lightweight programming language which embedded directly in HTML pages. It was designed to add interactivity to HTML pages. JavaScript is an interpreted language. It execute without preliminary compilation. Originally introduced by Netscape, it enables the

creation of dynamic HTML pages that process user input and maintain persistent data using special objects, files, and relational databases.

2.4.3.7 VBScript

VBScript is an interpreted script language from Microsoft that is a subset of its Visual Basic programming language. It was designed for interpretation by Web browsers. VBScript allows web developers to gain control of what happens in the browser and controlling data entry (for example--before data is sent back to the server). VBScript is designed for use with Microsoft's Internet Explorer browser together with other programming that can be run at the client, including ActiveX controls, automation servers, and Java applets. VBScript mimics the functionality of JavaScript in many ways, but it is not multiplatform.

2.5 Database Management

A database is any collection of facts that are systematically organized. Generally, there are three types of database such as Flat-File database, Relational database and Object-Oriented databases.

The basic characteristic of a flat-file database is that all information is stored together (in a single table). A common analogy of this type of database is a file cabinet filled with individual pieces of paper containing information. The only way to access this data is piece by piece. The relational database was designed to prevent the unnecessary duplication of data. The tables in the relational database is linked through keys to form relationships. As for the object-oriented database (OODB), the basic idea is that individual components of an application (objects, instances of a class) should be created once and then reused, extended, or modified. OODBs are very useful in niches that deal with complex data. It is also useful for multimedia data due to the ability of classes to inherit attributes and methods.

The studies of the DBMS is essential after studying the development platform, development softwares and supporting technologies. DBMS plays a significant role in the development of software. As such the major DBMSs that are recognized as the major player in the market is studied and discussed in the next section.

2.5.1 Microsoft Access

Microsoft Access was designed to be a relational database management system. Microsoft Access 2000 provides many new features that make working with data and designing a database even easier. The features offered are :-

i) **Use record-level locking** - A Microsoft Access database now supports record-level locking, in addition to page-level locking (which locks all records on a 4K page).

ii) **View related data in a subdatasheet** - User can use sheet to view and edit related or joined data in a table, query, or form datasheet, or in a subform all from the same view.

iii) **Automatically fix errors caused by renaming fields** - Name AutoCorrect automatically corrects common side effects that occur when renaming forms, reports, tables, queries, fields, text boxes or other controls.

iv) **Take advantage of Unicode support** - Characters of any language that Unicode supports can be used in the data. Unicode compression can offset the effect of Unicode's increased storage space requirements.

v) **Use Microsoft ActiveX Data Objects (ADO)** - Microsoft ActiveX Data Objects (ADO) can be used to access and manipulate data in a database server through any OLE DB provider.

Access also added with tools that make it web-savvy. These tools are Web converter and Web application wizard.

2.5.2 Oracle

Oracle boasts great performance and is the most feature-rich database on the market. It can run on Windows, Linux, or Unix and is built to handle extremely large databases. However, Oracle is somewhat complex to administer and very expensive. Below is a list of Oracle features :-

i) **Performance and scalability** - Oracle offers unlimited scalability with Oracle9*i* Real Application Clusters. Oracle9*i* Database Release 2 also delivers native XML support which enhance its performance.

ii) **High Availability** - Oracle guarantees the fastest recovery from failure with Oracle Fast Start Recovery. Oracle9*i* Database offers unbreakable reliability.

iii) **Security** - Oracle ensure security with 15 evaluations and counting.

iv) **Manageability** - Oracle requires only one tool to manage the enterprise. Online maintenance is allowed without taking the system down.

v) **Data Warehousing, OLAP, Data Mining** - Faster access to data with Oracle's single server for data warehousing and analytical processing. It is also no need to move data with Oracle9*i* OLAP.

2.5.3 MySQL Database Server

The MySQL database server is the world's most popular open source database. Its architecture makes it extremely fast and easy to customize. Extensive reuse of code within the software and a minimalistic approach to producing functionally-rich features has resulted in a database management system unmatched in speed, compactness,

stability and ease of deployment. The unique separation of the core server from the storage engine makes it possible to run with strict transaction control or with ultra-fast transactionless disk access, whichever is most appropriate for the situation.

Features of MySQL database server are :-

i) **ANSI SQL syntax support** - The MySQL database server supports a broad subset of the ANSI SQL 99 syntax, along with extra extensions such as the REPLACE statement and the LIMIT clause for SELECT and DELETE.

ii) **Cross-platform support** - It provide optimised binaries for a wide range of platforms, including Linux, Microsoft Windows, FreeBSD, Sun Solaris, IBM's AIX, Mac OS X and so-on.

iii) **Independent storage engines** - MySQL database server's unique independent storage engines for different needs. InnoDB storage engine is for row-level locking and transaction support while MyISAM storage engine is used for application which doesn't require transactions.

iv) **Transactions** Using the InnoDB or Berkeley DB (BDB) storage engines, the MySQL database server supports transactions.

v) **Flexible security system, including SSL support** - The MySQL database server has an advanced permissions and security system, including support for SSL transport-layer encryption.

vi) **Query caching** -Version 4.0 of the server includes a new query cache, which can significantly increase the performance of commonly-issued queries, without requiring any special programming.

vii) **Replication** Using database replication, user can have many "slave" servers running off a single "master" server for robustness and speed.

viii) **Full-text indexing and searching** - Full-text indexes allow user to search fields containing arbitrary text for specific words and phrases, including relevance rankings.

ix) **Embedded database library** - Using the embedded database library (libmysqld), the full power of the MySQL database server can be included into applications and electronics devices, without the end-user having any awareness of the underlying database.

2.5.4 PostgreSQL

Similar to MySQL, PostgreSQL is a free database server, and distributed with many versions of Linux. It offers the following features :-

i) **Legendary reliability and stability** - PostgreSQL has never, ever crashed for them in several years of high activity operation.

ii) **Extensible** - The source code is available free. There is no attached costs for customization or extension.

iii) **Cross platform** - PostgreSQL is available for almost every brand of Unix (34 platforms with the latest stable release), and native Windows compatibility will be introduced with PostgreSQL 7.4.

iv) **Designed for high volume environments** - Multiple row data storage strategy called MVCC to make PostgreSQL extremely responsive in high volume environments.

v) **GUI database design and administration tools** - Several high quality GUI tools exist to both administer the database (pgAdmin, pgAcess) and do database design (Tora, Data Architecture).

2.5.5 Microsoft SQL Server

Microsoft's database server is SQL Server. SQL Server's main advantages are the features it offers, its performance, and its integration with the .NET platform (for those who are already using .NET). It is generally targeted at midsized companies and for data-intensive work where large record sets are manipulated.

Microsoft SQL Server offers the following features :-

i) **Fully Web enabled**

- **Web Access to Data** - Connect to SQL Server 2000 databases and OLAP cubes flexibly, by using the Web with no additional programming.
- **Application Hosting** - With multi-instance support, SQL Server enables multiple applications to run on a single server, or outsourced.
- **Rich XML Support** – The integration of back-end systems and data transfer across firewalls is simplified using XML.

ii) **Highly scalable and reliable**

- **Scalability** – Applications can be scale up to 32 CPUs and 64 gigabytes (GB) of RAM.
- **Security** - Applications are secure in any networked environment, with role-based security and file and network encryption.
- **VI SAN** - Overall system performance improved with built-in support for a virtual system area network (VI SAN).

iii) **Fastest time to market**

- **Simplified Database Administration** - Automatic tuning and maintenance features enable administrators to focus on other critical tasks.
- **Data Transformation Services** - Automate routines that extract, transform, and load data from heterogeneous sources.
- **Improved Developer Productivity** - User-defined functions, cascading referential integrity, and the integrated Transact-SQL debugger allow the reuse of code to simplify the development process.

CHAPTER 3 METHODOLOGY

3.1 Concept Of System Development Methodology

A methodology is an organized set of guidelines for the process of developing a system. These guidelines define steps, tasks, techniques, roles, objects and deliverables required for success. As such, system development methodology can be defined as framework that is used to structure, plan, and control the process of developing an information system, application or software. This framework defines different phases of the development process, such as planning, requirements analysis, design, testing and maintenance.

Developing a software system is usually not done in a single night of hard work, but is a complex and time-consuming process. In order to control this process, software engineers try to adhere to certain framework that introduces certain degrees of structure to the overall development process. The disciplined, proven and repeatable set of processes of formal methodology help to reduce risks associated with complex development.

A wide variety of frameworks have been proposed over the years, beginning with the System Development Life Cycle or Waterfall models. These frameworks are generally divided into five major categories : linear, iterative, parallel, disruptive, or rapid response. Examples of these major approaches to system development methodology are stated as follows :-

i) **Linear models**

- System Development Life Cycle and Waterfall model.

ii) **Iterative models**

- Prototyping
- Spiral
- Rapid Application Development

iii) **Parallel models**

- Alternative Path
- Ad Agency Approaches

iv) **Disruptive models**

- Volcano Methodology

v) **Rapid Response models**

- Extreme Programming
- Adaptive Software Development

Modern methodologies must allow for a shortened development cycle as a result of the great demand of software markets for rapid product delivery. Therefore, multiple cycles through the development process are required, broadening the scope of deliverables as more functions are added through each cycle. A chosen methodology should allow for multiple, flexible paths (often called "routes") through the development process so that some projects (or parts of larger projects) may use a traditional phased approach while others use a more evolutionary, multi-cycle approach.

The methodology should also present a cohesive set of options to a methodologist, not distinct products to manage rigid, predefined methodology paths (routes).

Based on the assumption and consideration above, it is learnt that a good methodology that is suitable for a system is made up of a number of variables. Several authors have suggested methods for selecting the most appropriate development methodology for an application. Mahmood (1987) advised considering such things as availability of development tools and role of user satisfaction and commitment. Boehm (1988) suggested that risk should be used to drive methodology selection. McConnell's (1996) emphasis was upon such project characteristics as requirements and project risk.

Besides, it becomes the one of the concerns of the methodologist whether to select and adopt a single approach for software development. Single development methodology may bring advantages in terms of training, terminology, planning, estimate and the collection of process metrics standardization. However, there is also a possibility that there is not a single methodology that is clearly the best fit, as each of the approach may have certain shortcomings that are beyond the acceptance of the methodologist. Therefore, software engineer should create own 'best practice' by combining various aspects of the models.

3.2 Methodology Consideration

While using a single methodology may turn out to be too rigid and limited by its pitfalls, the methodology chosen for the project is a combination of Waterfall and Prototyping Models.

3.2.1 Waterfall Model

In software engineering, the waterfall model describes a development method that is linear and sequential. Because of the cascade from one to another, this model is known as Waterfall model. The waterfall model is also referred to as the systems development life cycle model.

Waterfall development has distinct goals for each phase of development just like a waterfall on the cliff of a steep mountain. Once the water has flowed over the edge of the cliff and has begun its journey down the side of the mountain, it cannot turn back. It is the same with waterfall development. Once a phase of development is completed, the development proceeds to the next phase and there is no turning back. In this model, the work is started at the system level and passes through phases of analysis, design, coding, testing and maintenance. These phases are discussed below :-

i) **Requirement Analysis And Definition**

System services, constraints, and goals are established at this starting phase. It is very important to ensure that definitions are properly documented to be defined in detail later to serve as a system specification. The requirement

analysis involves information gathering activities such as observation of the existing system, discussion with the potential user, task analysis and so on to understand the the system to be specified.

ii) **System And Software Design**

At this point, an overall of the system architecture is established from the system design. The system design partitions requirements to hardware and software systems while the software design represents software functions as a precursor to implementable executable programs. System Design serve as the critical part that involves activities such as architecture deisgn, system functionality design, system database design and user interface design.

iii) **Implementation And Unit Testing**

During this phase, program units are produced and each unit is tested to verify that it meets its specification. The main activities are coding and programming, to translate the system design into realization.

iv) **Integration And System Testing**

Program units are integrated into the system. The system is tested to verify that it meets specifications.

v) **Operation And Maintenance**

During this phase, undiscovered errors are corrected and implementation is improved. The maintenance phase also aims to enhance system services, and

modify or as new requirements are mandated or as needed through a series of adjustments.

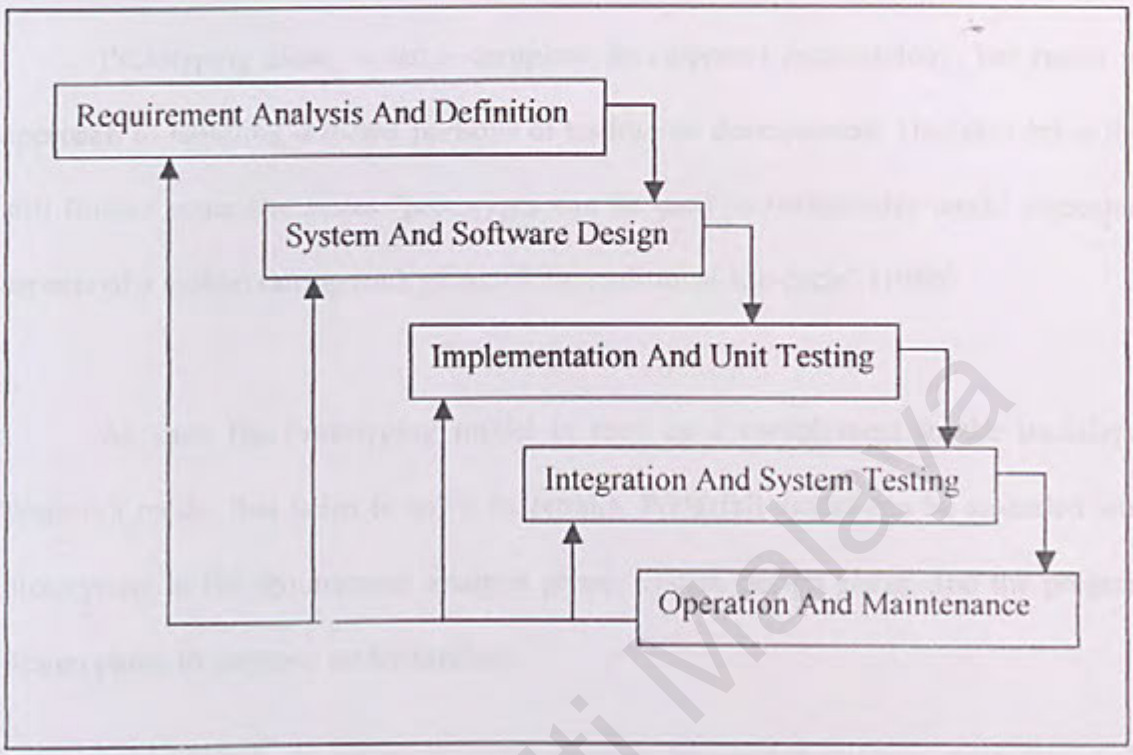


Figure 3.1 Waterfall Model

3.2.2 Prototyping Model

Prototyping is a technique used for quickly building a functioning, but incomplete model of the information system. According to Janson and Smith (1985), "Prototyping addresses the inability of many users to specify their information needs, and the difficulty of systems analysts to understand the user's environment, by providing the user with a tentative system for experimental purposes at the earliest possible time." Thus prototyping is an iterative process that lets users work with a

small-scale mock up of their system, experience how it might function in production, and request changes until it meets their requirements.

Prototyping alone is not a complete development methodology, but rather an approach to handling selected portions of traditional development. Huffaker takes this still further when she states "prototypes can be used to realistically model important aspects of a system during each phase of the traditional life cycle" (1986).

As such the Prototyping model is seen as a complement to the traditional Waterfall model that helps to solve its pitfalls. Waterfall model can be amended with prototyping in the requirement analysis phase, system design phase, and the program design phase to improve understanding.

The requirement prototyping aims to ensure that the requirements are feasible and practical. If the prototype is not acceptable, then the revisions are made at the requirement stage. Design prototypes are conducive in providing alternative strategies to decide the best design for the project.

The improved waterfall also added with validation and verification activities in the system testing phase. The validation process traces back particular requirement in the specification to ensure a right product is built. Verification is then carried out to ensure the quality of the implementation by checking the correctness of the work functions.

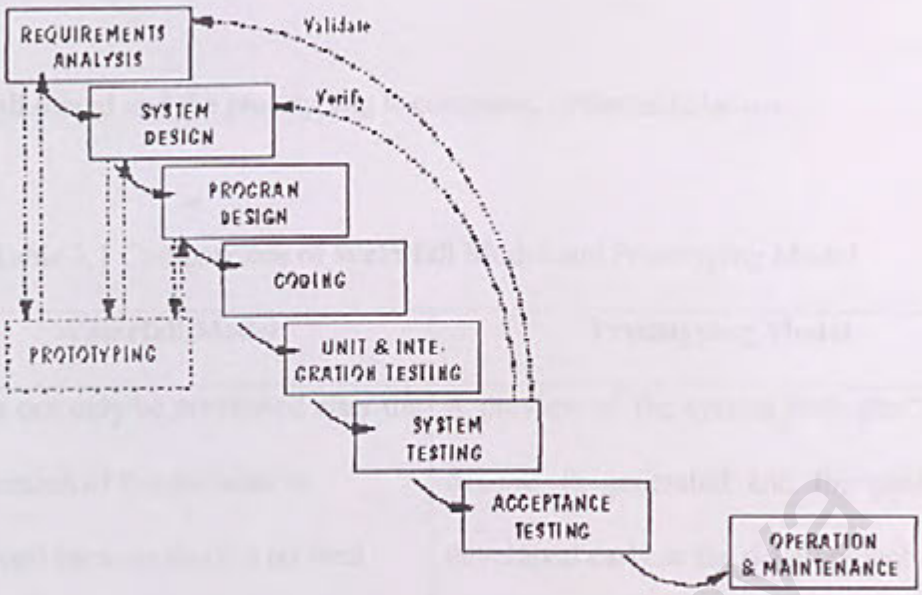


Figure 3.2 Improved Waterfall Model With Prototyping

3.3.3 Comparisons Between Waterfall Models And Prototyping Models

The advantages of the waterfall model are :-

i) Simple and easy to understand.

ii) A schedule can be set with deadlines for each stage of development to ensure that the product can be delivered on time.

iii) Easy to associate measures, milestones and deliverables with the different stages.

However, it also has some drawbacks. These drawbacks are :-

i) Inflexible portioning of the project.

ii) Does not allow for much reflection or revision.

iii) Difficult to respond to changing customer requirement.

The waterfall model and the prototyping is compared in the table below :-

Table 3.1 Comparisons of Waterfall Model and Prototyping Model

	Waterfall Model	Prototyping Model
1.	System can only be previewed after the final version of the software is developed because there is no feed back loop.	A preview of the system from the "quick design" is generated and the prototype developed early at the development of the process.
2.	Modifications of requirements or specification of the previous phase are not allowed until the next iteration.	Requirements and specification can be added and refined after the prototype is built.
3.	The complexity of an error increases because each phase is sequential of the other.	The complexity of an error is low because the prototype enables detection of any deficiency early at the process.

Considering both the advantages and the drawbacks of the waterfall models, a combination of waterfall model and prototyping model is chosen for this project. The prototyping model is combined to minimize the effect of the waterfall model. The choice is also made because in the situations stated as below, it is found that the improved waterfall is more beneficial. These situations are :-

CHAPTER 4 SYSTEM ANALYSIS

4.1 System Analysis Overview

System analysis is defined as the study of a business problem domain to recommend improvements and specify the business requirements for solution, according to Whitten L. Jeffrey (2002). It serve as a problem solving technique that decomposes a system into its component pieces for the purpose of studying how well those component parts work and interact to accomplish their purpose.

System analysis is done in the early phases of system development to perform a system design later. System analysis involves preliminary investigation of a proposed project, the study and problem analysis of the existing system, the requirement analysis of the business requirement for the new system and the decision analysis for alternative solutions to fulfill the requirements. Each of this activity is crucial to gather useful and critical information that will serve as input for a good system design.

It is common that the objectives, requirements and constraints are unclear in initial stage of a system development. There are many uncertainties within the organization, client side and surrounding environment that may result major impact in the project planning. System analysis not only helps software engineer to identify a better course of action and make a better decision, but also help to examine of the probable consequences of the alternatives in terms of costs, benefits, and risks; presentation of the results in a comparative framework.

The system analysis is done with the major objectives and concerns stated as the following :-

- To do research and study on the functionalities and features, as well as the problems in the existing system. The research will then serve as references to generate ideas for proposed system.
- To have better understanding of the process in which teacher and lecturer setting up examination papers.
- To gather critical information of the users' requirements by understanding their problems.
- To identify major functions to be included in the systems.
- To recognize possible resources used to develop the system such as software and hardware specification.

4.2 Requirement Discovery Methods

System analysis attempts to express user requirements for the proposed system. As such, the problems and solution requirement is extracted in the requirement discovery using several techniques. The Common approaches are Fact-Finding techniques, Join Requirement Planning (JRP) and Business Process Redesign (BPR).

In the EPAP system, Fact-Finding techniques are used to collect information about the system problems, opportunities, solution requirement and priorities.

4.2.1 Interview

The face-to-face interview with the teachers is carried out to collect information about how the examination papers are created and processed. Interview sessions allow information gathering, facts verification, facts clarification, end-user involvement. Interview is very important in identifying requirements, soliciting ideas and opinions because software engineer get direct response, feedback immediately.

Unstructured interviews are conducted with Mrs Ng Choy Ying, a secondary school teacher in Kuantan and Mrs Khew Hui Min, a primary school teacher who is currently doing further studies in University Malaya. Open ended questions are asked to allow any appropriate responses. They have provided useful and valuable information about the teachers' role and duties in examinations and generally how the examination papers is produced currently using Word program. These interviews are rather unstructured to be recorded, however the examination papers samples are included as appendix.

4.2.2 Literature Research

Reference Books, previous thesis are studied to acquire knowledge in various aspects in order to have better understanding of the proposed system as a whole. References books provide knowledge that guide through the development process. This important knowledge includes methodologies, techniques, technologies, guidelines and management skills. Previously done thesis that develop similar project is referred to have a general idea of what to be included and improved in EPAP.

4.2.2 Internet Browsing

The Internet has provided vast information that encourages knowledge sharing. As a result, Internet users are benefit from the borderless knowledge sharing across the wide area network. Free articles from the professionals in the system development fields can be downloaded as references. Plenty of latest technology information is available in the Internet. The search engines such as Google, AltaVista and Lycos are used to search information needed. Information is gathered, compared and analyze to guide the decision making and to be referred in the system development process. Besides, the existing systems that are similar to EPAP can be found in the Internet. The features of the available system in the market are studied to generate ideas for the proposed system.

4.2.3 Discussion

Discussions are carried out to share knowledge and to exchange ideas, opinions with supervisor, and among peers. When there is a bottleneck problem during the system development, it is always useful to seek advice and opinions from others. Their recommendations and advices can help in solving problems and identifying other alternatives for solutions.

4.3 Requirement Analysis

As requirements are solicited from many different sources, there are chances where conflict will occurred because there will be too many different desires and opinions for the functionality of the new system. Discovery in the requirement analysis will help to discover and resolve the problems with the requirement and reach the decision after evaluating the possibilities of the suggested features in the proposed systems. The outcomes of the requirement analysis are functional requirements and non-functional requirements of the EPAP stated in the next section.

4.3.1 Functional Requirements

Functional requirements are functions and features to be included in a system to satisfy business need and be acceptable by users. In EPAP, the functional requirements identified are stated as below :-

4.3.1.1 Overall System

4.3.1.1.1 Account Initiation and User Profile Module

Before a user can access to the system, a user should have an account in the system that recognize the user. Only permitted user can proceed to use the functionalities in the system.

4.3.1.1.1.1 The user needs to register for an account by filling up a form with their personal details, user name and password.

4.3.1.1.1.2 The system should allow the user to enter into the system with the registered users with the valid password in the next section.

4.3.1.1.2 User Authentication Module

4.3.1.1.2.1 Registered user must enter valid and correct user name and password is allowed to enter into the system. This authentication procedure is to ensure security of the system.

4.3.1.2 System Administrator Module

4.3.1.2.1 User Authorization

Before a user can access to the system, a user should have an account in the system that recognize the user. The administrator will give authorization to those who is qualified and permitted base on the administration policies. Only authorized user can proceed to use the functionalities in the system.

4.3.1.1.2.1 Administrator can view a list of registered users.

4.3.1.1.2.2 Administrator can select unauthorized users and disable them from using the system.

4.3.1.2.2 Database Maintenance

4.3.1.2.2.1 Administrator can select the inactive user and delete the user account.

4.3.1.3 User Module

4.3.1.3.1 Personal Details

4.3.1.1.1.1 Existing user is allowed to change their password and modify their personal details.

4.3.1.3.2 Exam Editor

Constituted by four sections such as Examination Properties, Multiple Choice Questions, Structured Question and Essay question, the Exam Editor is the core module in the EPAP system where the major functionalities reside. This module allows teacher to create examination papers with three question types.

4.3.1.3.2.1 User is required to enter the examination properties such as the examination title, date, time, venue and instructions.

4.3.1.3.2.2 User is offered with the three question types as explained.

4.3.1.3.2.3 User may also include images or graphics that are supported by the database.

4.3.1.3.2.4 User is allowed to save the created question, retrieve to edit and delete.

4.3.1.3.3 Printing Hall

This is the platform where user can retrieve back the saved question paper for printing and preview purposes.

4.3.1.3.3.1 User is allowed to choose to preview or print the saved quizzes, tests or examination paper.

4.3.1.3.3.2 The system should list down all saved files under the same category which is chosen by the user so that user can choose to preview or print the particular file.

4.3.1.3.3.3 The system should also display the papers preview before printing in a standardized layout.

4.3.1.3.3.4 User can click the 'Print' button for printing purpose.

4.3.2 Non - Functional Requirements

Non-functional requirements are as important as the functional requirements even though they are described as those requirements which are not directly concerned with the specific functions delivered by the system. It describes the features, characteristics and attributes of the system as well as the constraints that may cause limitation to boundaries of the solution.

Non-functional requirements are relate to the system as a whole rather than to individual system features. It is considered as even more critical than functional requirements because failure to meet the non-functional requirements may cause catastrophic results, making the system unusable. As such the non-functional requirements are taken seriously in this project. The non-functional requirements concerned in the EPAP system are identified as below :-

4.3.2.1 Usability

The user of the EPAP system should find the system usable. They work flow of the system should be clearly and easily understandable in which no great effort should be done to understand how to use the system. User shall be able to create question papers immediately after they have accessed into the system with least guidance. However, appropriate user interface is implemented and instructions are stated to ensure the usability of EPAP.

4.3.2.2 Reliability

EPAP should be developed with great reliability. It should provide stable performance that the teacher can rely on. The database should be stable enough as the data saved is vital to the system and also the user. It is also critical to maintain the integrity of the data. The system should also provide good availability as teachers require frequent usage of the system. Besides, the system should be error –free to avoid any data lost that will affect the user's jobs.

4.3.2.3 Performance

Good performance of the EPAP is required to meet the user's needs. As teacher's workload is heavy, the response time of the system should be fast enough for all processes. The database should work well in data capturing and retrieving as the data is the vital element in this system. The database should be able to handle massive data-flow.

4.3.2.4 Security

The main concern of the EPAP system is the security issues. Examinations information must be kept confidential to any unauthorized parties. It is to avoid the leakage of the questions before the examination and to ensure fairness to all candidates. As such, the system must be protected with great security to secure the data.

4.4 Development Technologies And Tools Consideration

Based on the literature review in Chapter 2, the development technologies and tools are chosen after taking into consideration of both their advantages, disadvantages. The comparisons of the technologies and the development tools can be found in the following sessions.

4.4.1 Development Platform – 2-tier VS 3-tier/multi-tier Client/Server Architecture

In 2-tier client/server environment, processing management is split between the user system interface environment and the database management server environment. A client runs majority of the application logic, sends requests to a server-resident database. On the other hand, a middle tier is added between the user system interface client environment and the database management server environment in 3-tier architecture. The processing management is split into three sections :-

1) Clients that run the graphical user interface (GUI) logic,
2) The application server running the business logic,
3) The database or legacy application.

Table 4.1 shows the comparisons of the two architectures :-

Table 4.1 2-Tier Architecture VS 3-Tier Architecture

Criteria	2-tier	3-tier / multi-tier
System Administration	Complex - more logic on client to manage	Less complex - applications can be centrally managed on server
Security	Low data level security	High - fine-tuned at service or method level
Data Encapsulation	Low - data tables are exposed	High - client invokes services or methods
Performance	Poor - limited management of client communication links	Good - only service requests and responses are sent between the client and the server
Scale	Poor - limited management of client communication links	Excellent - concentrates incoming sessions; can distribute loads across multiple servers
Application reuse	Poor - monolithic application on client	Excellent - can reuse services and objects
Ease of development	High	Getting better
Server-to-server infrastructure	No	Yes
Legacy application integration	No	Yes - via gateways
Internet support	Poor	Excellent - thin clients are easier to download as applets or beans; remote service invocations

		distribute the application load to the server
Heterogeneous database support	No	Yes
Rich communication choices	No	Yes - can support most kinds
Hardware architecture flexibility	- only synchronous, connection-oriented RPC-like calls	Excellent - the tiers can be on multi-platform environments
Availability	Poor	Excellent - can restart middle tier components on other servers

Source : http://www.ise.canberra.edu.au/u4349/lect41.htm

The architecture chosen for EPAP system is multi-tier Client/Server platform. The web-based multi-tier Client/Server platform choice is made base on the major concerns stated as below :-

i) System administration is less complex, thus it is easier for the administrator to manage the system. As EPAP requires proper and secured administration, an easy system administration is essential.

ii) Better performance in terms of speed of the processing to meet user's needs

iii) Re-definition of the storage strategy won't influence the clients. RDBMS' offer a certain independence from storage details for the clients.

iv) Data protection and security is critical in the EPAP. In multi-tier architecture, data protection and security is simpler to obtain as the authorization of "trusted" rule servers is simpler than that of numerous "untrusted" client-PCs.

4.4.2 Development Technologies - ASP.NET VS ColdFusion

Two potential technologies to be used had been compared. The choice of the technologies is based on the consideration of the following criteria.

Table 4.2 ASP.NET VS ColdFusion

Criteria	ASP.NET	ColdFusion
Language	Supports multiple languages including VB.NET, C#.	CFML and Java, and supports open extensibility with C/C++
Complexity of coding	Still new and more complex, supports multiple, extensible scripting languages.	CF's tag syntax is simpler and easier to code.
Performance of language	ASP.net tends to be a bit quicker since it compiles to binary.	A bit slower than ASP.NET since interpretation takes time.
Portability	For Microsoft Windows platform only.	For Windows, Solaris, and Linux platforms.
Web Server Support	Microsoft IIS only.	Any CGI compliant web server, a number of servers using native APIs (ISAPI, NSAPI, WSAPI, etc).

Error Handling	Process to trap and handle errors in script is limited.	Allows specification of a default error handling HTML template, into which error information is plugged, much easier to display consistent and complete error information. Ability to trap errors in script and take conditional action.

ColdFusion is chosen over ASP.NET for the development of the EPAP because the simplicity of the CFML has meet the needs to develop the EPAP in a limited time given. It needs time to explore and to be familiar with the new technology of ASP.NET, specially for inexperienced programmer. Coldfusion has various predefined functions in different categories that greatly reduces the coding time needed and simplifies the coding as well. ColdFusion is also chosen based on its advantages over ASP.NET as compared in the table above such as its portability and error handling ablity.

4.4.3 Development Servers – Microsoft IIS VS Apache

In the 3-tier or multi-tier Client/Server environment, a web server or an application server is needed. Web servers that had been taken into consideration are Microsoft IIS and Apache Web servers. The comparisons of these web servers can be found in the Table 4.3.

Table 4.3 Microsoft IIS VS Apache

Criteria	IIS	Apache
Availability	Can be found in Windows 2000, Windows XP and the latest Windows 2003 Server.	Number one server used on the Internet by a 2-to-1 margin.
Flexibility	Low flexibility. Microsoft offers many different server products	Open Source software that can be installed, configured to fit user's need
Security	More risky due to the vulnerability to hacking.	More secure.
Reliability	New fault-tolerant process architecture make .NET applications more reliable.	Runs non-stop for months without crashing.

Although the Apache Web Server has many advantages over IIS, IIS is chose as the Web Server of EPAP because the Apache Server needs special skill to maintain. IIS is suitable in developing EPAP system as the targeted user is expected to use the Windows platform. With responsive enhancement to the security of the IIS is believed to be able to reduce risks.

4.4.4 Development Operating System – Windows 2000 VS Linux

The comparisons of Windows 2000 over Linux can be found in The table 4.4.

Table 4.4 Windows 2000 VS Linux

Criteria	Windows 2000	Linux
Reliability	Rather poor reliability.	Dependable OS.
Performance	Windows is adequate for routine desktop apps, but it is unable to handle heavy network loads.	Linux performs well for most applications, however the performance is not optimal under heavy network load.
Security	Rather vulnerable.	Include a very robust packet filtering firewall system and many intrusion detection tools.

Realized that the Linux is not user-friendly and is not commonly used among the targeted users, Windows 2000 is chosen to be the development OS for EPAP system. In addition, it has high popularity, thus it improves the marketability of the EPAP. Windows 2000 supports languages such as ColdFusion. Besides, ODBC also found in Windows 2000 and it support the SQL server that will also be used in developing EPAP.

4.4.4 Development DBMS – Microsoft Access VS Microsoft SQL Server

A DBMS is responsible for data storage. In order to choose a suitable DBMS for EPAP, Microsoft Access and Microsoft SQL Server had been evaluated. Table 4.5 shows their comparisons.

Table 4.5 Microsoft Access VS Microsoft SQL Server

Criteria	Microsoft Access	Microsoft SQL Server
Category	File based database solution designed to function in a desktop environment.	Enterprise database for client/server environment.
Number of concurrent users	255	Limited by available memory
Database Size	2 GB plus linked tables size	1,048,516 TB

The powerful Microsoft SQL server is chosen because it provides large storage for data in which most needed by the EPAP. It also allows multiple user connect concurrently. SQL Server 2000 can handle 709,220 transactions per minute. It has further established its position as the fastest database in the world. Besides, Data integrity and security are the primary concerns. Meanwhile, Client/server databases also support important features such as user security, triggers, stored procedure and scheduled execution to make a system secure and scalable.

4.5 Hardware And Software Requirements

The determination of the development technologies and tools is then lead to the specification of the hardware and software that serve as the resources required to build the EPAP system. The hardware and software requirements of both the server side and client can be found in Table 4.6 and Table 4.7.

4.5.1 Server Side And Client Side Hardware Requirements

Table 4.6 Server Side And Client Side Hardware Requirements

Component	Recommended Server Side Requirements	Recommended Client Side Requirements
Processor	Intel Pentium processor III 550 MHz or higher	Pentium II 250 MHz or higher
Memory (RAM)	256 MB	128 MB
Hard Disk Space	20GB	2GB or higher
Networking	Network Interface Card	56K modem
Display	VGA	VGA
Peripherals	CD-ROM, sound card, display card, mouse, keyboard.	CD-ROM, sound card, display card, mouse, keyboard.

4.5.2 Server Side And Client Side Software Requirements

Table 4.7 Server Side And Client Side Software Requirements

Description	Server Software	Client Software
Operating System	Microsoft Windows 2000 Professional	Windows 98/ME/2000/XP
Web Server	Microsoft IIS 5.0	-
Application Server	ColdFusion 5.0	-
DBMS	Microsoft SQL Server 2000	-
Web Browser	-	Internet Explorer 6.0

CHAPTER 5 SYSTEM DESIGN

5.1 System Design Overview

System design is physical design of an information system solution that focuses on the technical and implementation concerns. It is a description of the structure of the system to be implemented, the data as a part of the system, the interfaces between the system components, and the algorithms used. The system design phase follows the system analysis phase in the waterfall model. During the system design phase, the functional requirements and the non-functional requirement that had been identified in the system analysis phase are translated and converted into a blueprint of the proposed system.

The conventional system design involves a series of design process activities such as the architectural design, abstract design, interface design, component design, data structure design the algorithm design. For EPAP system, the design process activities include architecture design, system functionality design, database design and the user interface design.

5.2 System Design Approach

There are many strategies or techniques for performing system design. These strategies include modern structured design, information engineering, prototyping, joint application development, rapid application development and object-oriented design. The EPAP system approach is the modern structured design approach.

As a process oriented technique, the modern structured design break up a program into a hierarchy of modules that result in a computer program that is easier to implement and maintain. A program is designed as a top-down hierarchy of modules. The deliverable of the structured design is a structure chart which derived by studying the flow of data through the program. The structure chart helps software engineer to deal with the size and complexity of the program.

As the structured design approach with the structure chart provides clearer view of the system in general, it is suitable for the development of the EPAP system. The approach is also chosen for the ease of the system implementation.

5.3 Architectural Design

The process of architectural involves establishing a basic framework for a system. Major component of the system and the communications between these components are identified.

The EPAP system will be built as a distributed system in which the data, process and the interface components of the system are distributed to multiple locations in a computer network. In this case, the computer network is refers to the wide area network, Internet. The architecture of the web-based EPAP system is client/server to implement the distributed characteristic. EPAP has a thin-client architecture which allocates only the interface and display logic to the client, leaving the heavier load which consists of application logic, processing, and database processing to the server.

The client/server can be 2-tier, 3-tier or N-tier. The advantages of these architectures are discussed earlier in Chapter 2. EPAP is implemented in an '4-tier' web oriented architecture which leads to faster network communications, greater reliability, and greater overall performance. The N-tier client/server architecture has several benefits, such as :-

i) Different aspects of the application can be developed and rolled out independently.

ii) Servers can be optimized separately for database and application server functions.

iii) Servers can be sized appropriately for the requirements of each tier of the architecture.

iv) More overall server horsepower can be deployed.

Figure 5.1 shows a 4-tier client/server system that connected to each other in the Internet. In the case of EPAP system, the database server used is Microsoft SQL server, the application server is ColdFusion and Web server is Microsoft IIS.

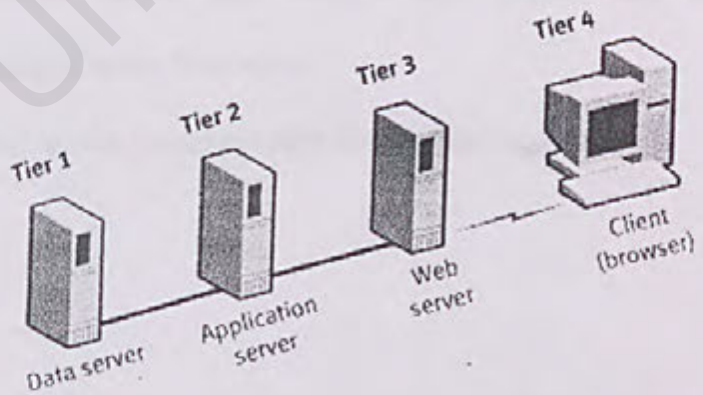


Figure 5.1 Web-Oriented N-Tiered Architecture

The ColdFusion application server located on the second tier processes application pages on the server at runtime, each time they are requested by a browser. A page request happens when user click on a Web site link to open a Web page in thebrowser. When a request of a ColdFusion application page is made, ColdFusion server processes the request, retrieves any data if necessary, routes the data through the Web server, back to the client browser.

Figure 5.2 shows the request processing in the 4-tier environment with Coldfusion application server. The sequence of the process are :-

1) The client requests a page that contains CFML tags.
2) The Web server passes files to ColdFusion Server if a page request contains a ColdFusion file extension.
3) ColdFusion Server scans the page and processes all CFML tags. It run CGI scripts for dynamic content, parse database requests, or assemble formatted responses to client queries, accessing dates or files as needed from a back-end database server or a file server.
4) ColdFusion Server then returns only HTML and other client-side technologies to the Web server.
5) The Web server passes the page back to the browser.

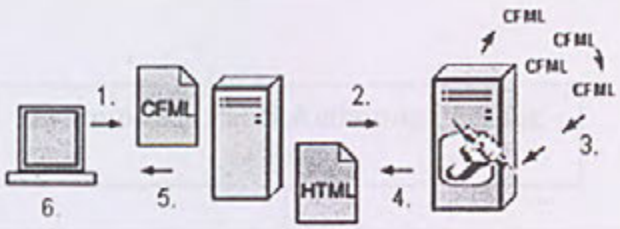


Figure 5.2 File request processing in ColdFusion server environment.

5.4 Functionality Design

After the conceptual system architecture has been designed, the next stage is the decomposition of the system into modules. The system is decomposed into functional modules that accept input data and transform it, in specific way, to output data. The system functionalities are decomposed in such a way that it is not cluttered in details. Thus, the stakeholders including the software engineer can relate to it and understand an abstract view of the system. This type of structuring is effective for communication with the system stakeholders and for project planning.

5.4.1 Structure Chart

A structure chart is a software model which derived from structured design. The structure chart depicts the high level abstraction of the system. It also shows the relationship and the interaction between each modules and their component. It helps to identify the key sub-systems that will be independently developed, so adequate resources can be allocated to the development of these systems. The EPAP system functionalities decomposition can be depicted in the following structure charts.

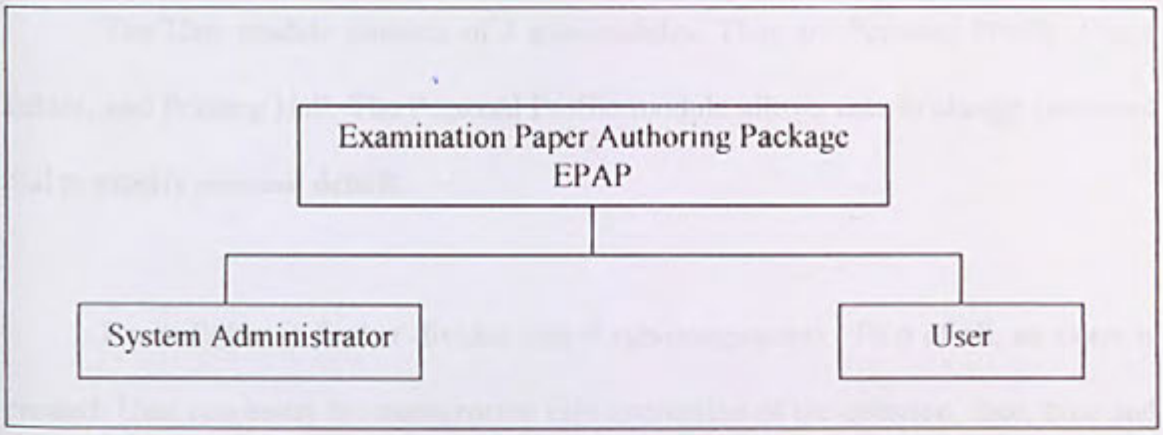


Figure 5.3 Structure Chart : EPAP Major Components

The EPAP system can be divided into 2 major parts. The first part is focus on the service for system administrator. The second part is concerning the main users of the EPAP such as teachers and lecturers. Valid user name and password are the prerequisite for the EPAP system access. As such, user must register first in the Account Initiation And User Profile module. Once registered, the user can login as administrator or lecturer with the registered username and password through the Authentication module.

The System Administrator module has two major functions. It gives authorization to the valid users to use the EPAP system. The system administrator also responsible in the database maintenance in which he will delete the user from the database when the user is no longer active in the system.

The User module consists of 3 sub-modules. They are Personal Profile, Exam Editor, and Printing Hall. The Personal Profile module allows user to change password and to modify personal details.

Exam Editor is further divided into 4 sub-components. First of all, an exam is created. User can insert the examination title instruction of the question, date, time and venue of the examination in the Exam Properties Modules. Exam Editor module let user to choose three question types in the creation of the question papers. The question types are multiple choice question, structured question, and essay question. User is allowed to edit and delete the question he or she has created. The exam can be deleted if needed. When the paper is done, the paper can be retrieve in the Printing Hall section to be printed out.

In the Printing Hall section, the examination papers that had been created in the Exam Editor module will be listed out. User can select to preview the paper and then print it out. Figure 5.4 and Figure 5.5 illustrate the further decomposition of each of the major components in EPAP.

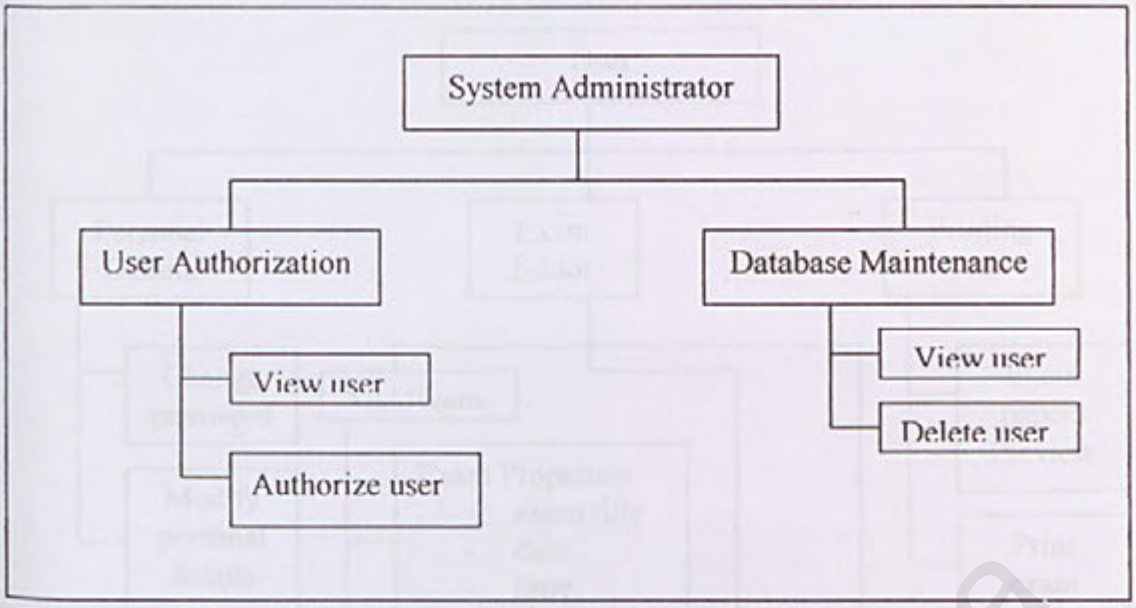


Figure 5.4 Structure Chart : System Administrator Module

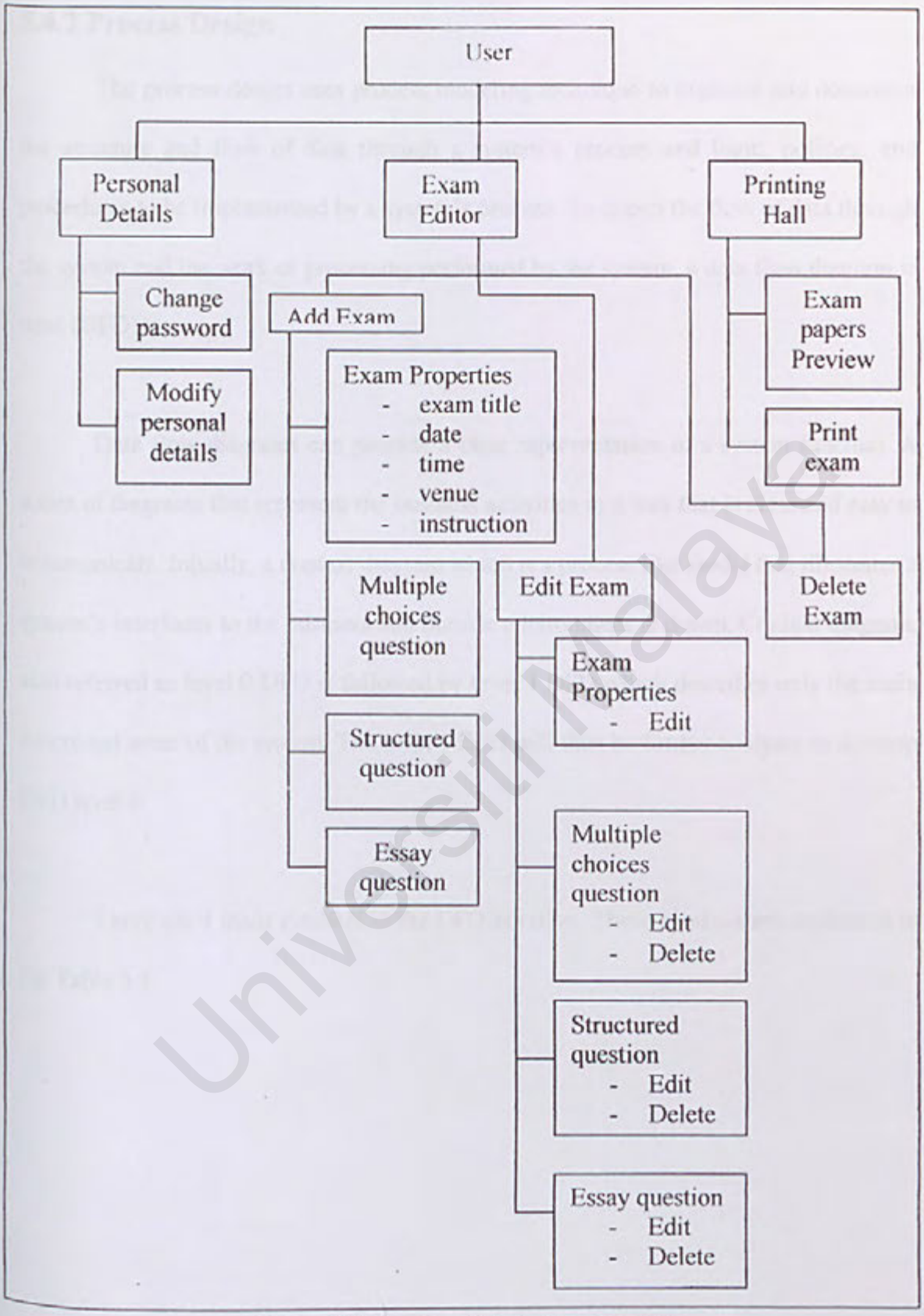


Figure 5.5 Structure Chart : User Module

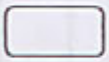
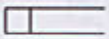
5.4.2 Process Design

The process design uses process modeling technique to organize and document the structure and flow of data through a system's process and logic, policies, and procedures to be implemented by a system's process. To depict the flow of data through the system and the work or processing performed by the system, a data flow diagram is used (DFD).

Data flow diagrams can provide a clear representation of a system function. A series of diagrams that represent the business activities in a way that is clear and easy to communicate. Initially, a context diagram which is a process like model that illustrates a system's interfaces to the business and outside environment is drawn. Context diagram, also referred as level 0 DFD is followed by level 1 DFD which describes only the main functional areas of the system. The level 1 DFD will then be further analyses to develop DFD level 0.

There are 4 main symbols in the DFD notation. These symbols are explained in the Table 5.1.

Table 5.1 DFD Notations

Symbol	Name	Description
	External entity	Source or destination of a data flow.
	Process	Transformation or manipulation of data flows within the system.
	Data store	Files or database.
	Data flows	Input or output from the process.

5.4.2.1 Context Diagram

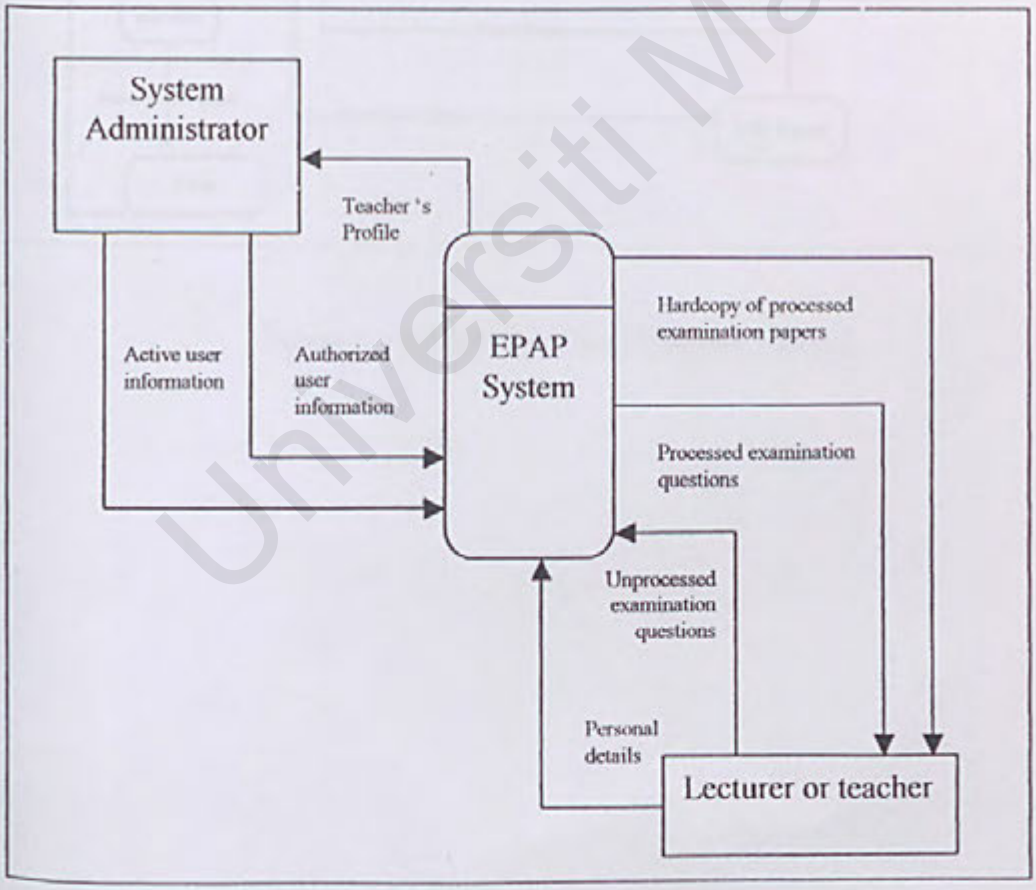


Figure 5.6 EPAP Context Diagram

5.4.2.2 DFD level 1

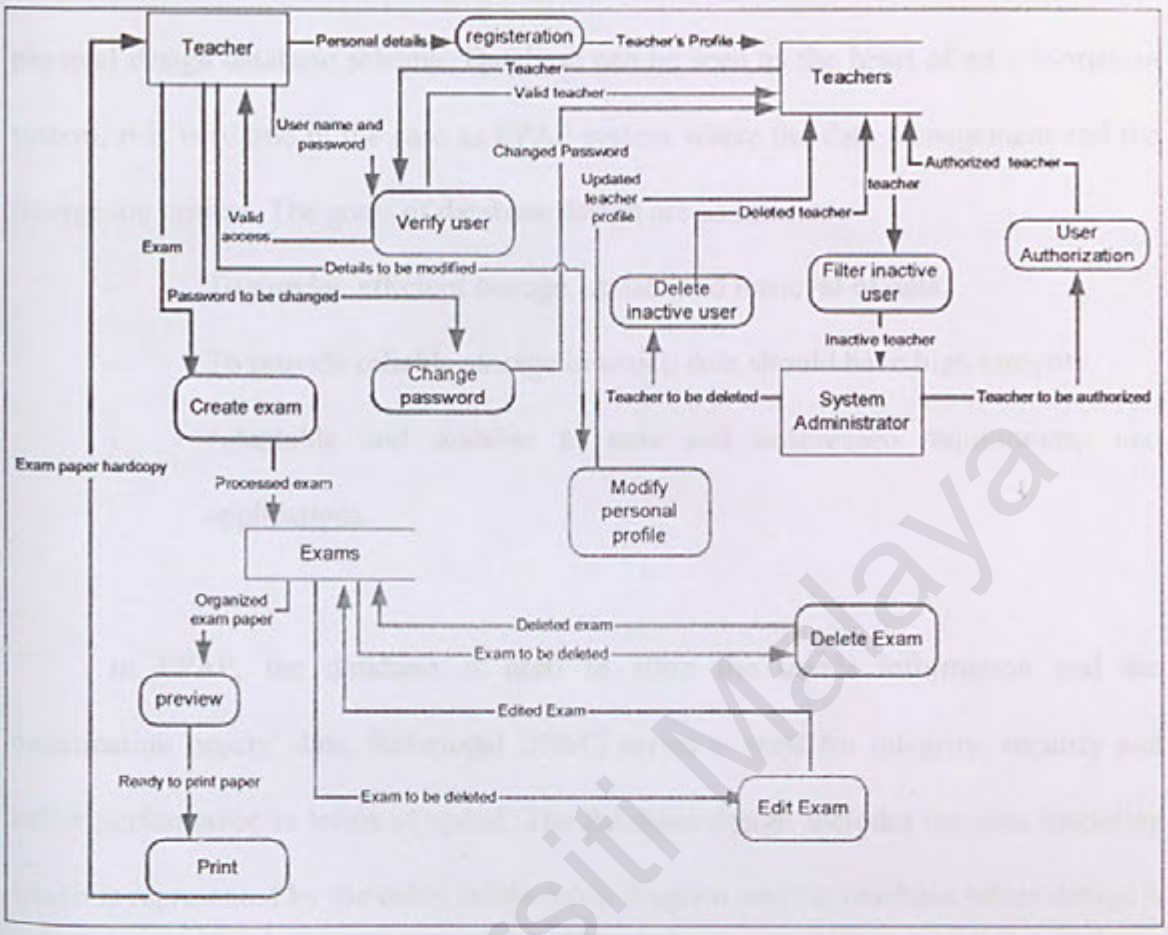


Figure 5.7 EPAP Data Flow Diagram Level 1

5.5 Database Design

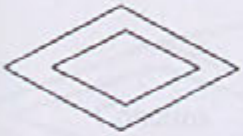
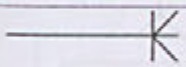
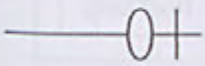
Database design is the process of translating logical data models into the physical design database schema. Database can be seen as the heart of an information system, it is very true in the case as EPAP system where the data management and the storage are critical. The goals of database design are as follows :-

- To provide efficient storage, update and retrieval of data.
- To provide reliable storage in which data should have high integrity.
- Adaptable and scalable to new and unforeseen requirements and applications.

In EPAP, the database is used to store the user's information and the examination papers' data. Relational DBMS server is used for integrity, security and better performance in terms of speed. The database design includes the data modeling which is represented by the entity relationship diagram and the database tables design is presented through the data dictionary.

The ER diagram notations can be found in the Table 5.2.

Table 5.2 ER Diagram Notations

Symbol	Name	Description
	Entity	Objects or concept about which we need to capture and store data.
	Weak entity	A weak entity is dependent on another entity to exist.
	Relationship	Relationships illustrate how two entities share information in the database structure.
	Weak relationship	A weak relationship connects a weak entity with others.
	Cardinality	Many to many
	Cardinality	One to many.
	Cardinality	Zero to one.

5.5.1 Entity Relationship Diagram, ERD

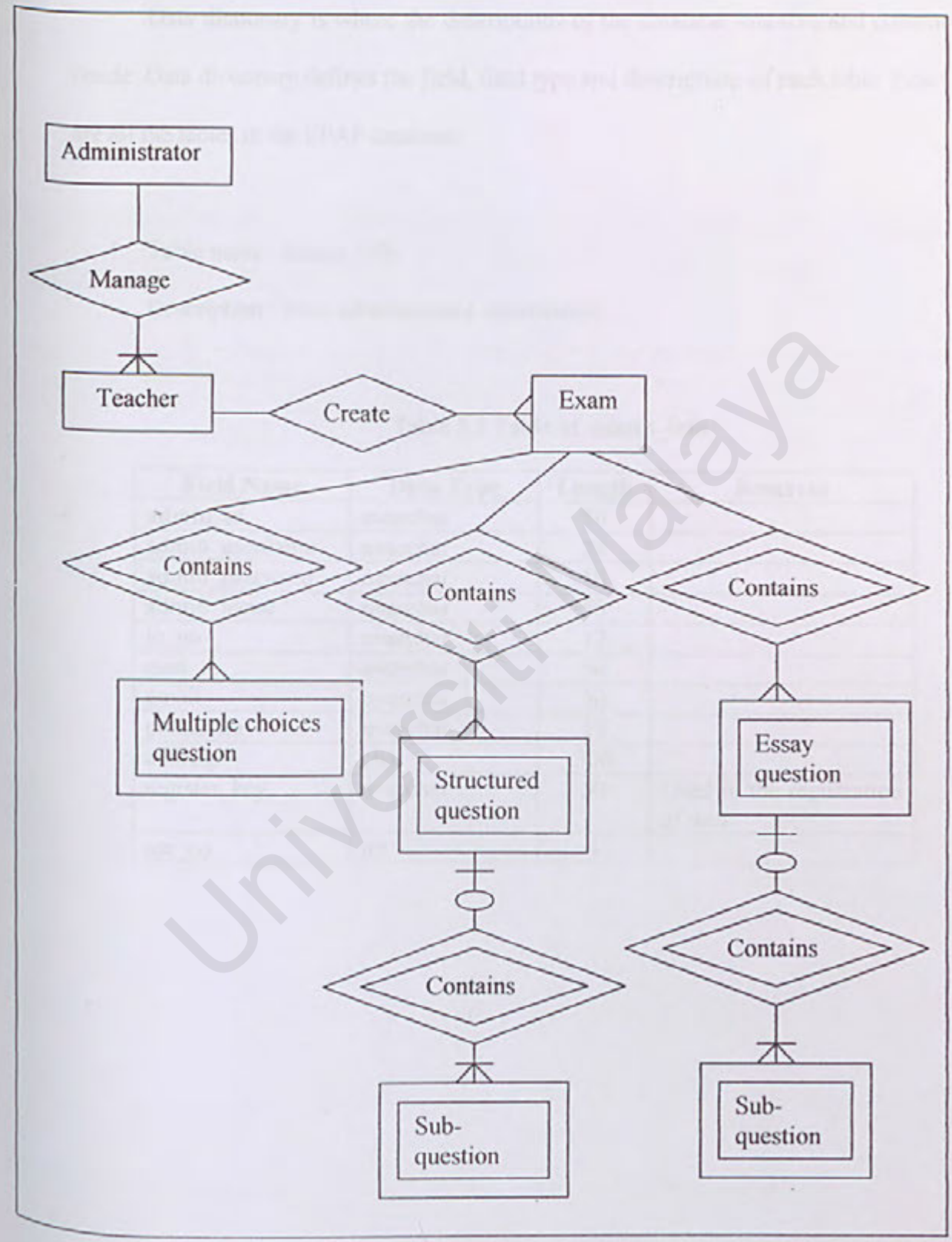


Figure 5.8 EPAP ER Diagram

5.5.2 Data Dictionary

Data dictionary is where the descriptions of the database structure and contents reside. Data dictionary defines the field, field type and descriptions of each table. Below are all the tables in the EPAP database.

1. Table name : admin_info

   Description : Store administrator information

Table 5.3 Table of admin_info

Field Name	Data Type	Length	Remarks
admin_id	nvarchar	50	
admin_username	nvarchar	50	
admin_password	nvarchar	10	
admin_name	nvarchar	50	
ic_no	nvarchar	12	
post	nvarchar	50	
email	nvarchar	50	
phone_no	nvarchar	12	
address	char	300	
register_key	nvarchar	50	Used in the registration of user.
rec_no	int	4	

2. Table name : teacher_info

Description : Store teacher's information.

Table 5.4 Table of teacher_info

Field Name	Data Type	Length	Remarks
teacher_id	nvarchar	50	
teacher_username	nvarchar	50	
teacher_password	nvarchar	10	
teacher_name	nvarchar	50	
ic_no	nvarchar	12	
subject1	nvarchar	50	
subject2	nvarchar	50	
subject3	nvarchar	50	
sub_code1	nvarchar	50	
sub_code2	nvarchar	50	
sub_code3	nvarchar	50	
email	nvarchar	50	
phone_no	nvarchar	12	
address	nvarchar	300	
status	nvarchar	50	new, authenticated, disabled
rec_no	int	4	

3. Table name : exam

Description : Store information about examination which created by particular teacher.

Table 5.5 Table of exam

Field Name	Data Type	Length	Remarks
teacher_id	nvarchar	50	
exam_id	nvarchar	50	
school_name	nvarchar	100	
exam_title	nvarchar	100	
exam_session	nvarchar	50	
exam_type	char	1	Q-quiz, T-test, E-exam
subject	nvarchar	100	
subject_code	nvarchar	50	
exam_date	datetime	8	
exam duration	nvarchar	50	
exam_time	nvarchar	50	
exam_venue	nvarchar	50	
instruction	nvarchar	1000	
ques_type	nvarchar	50	mcq, structured, essay
total_marks	int	4	
total_ques	int	4	
rec_no	int	4	

4. Table name : mcq_question

Description : Store multiple choice questions for an examination.

Table 5.6 Table of mcq_question

Field Name	Data Type	Length	Remarks
exam_id	nvarchar	50	
teacher_id	nvarchar	50	
ques_no	int	3	
instruction	nvarchar	300	
marks	int	3	
question	nvarchar	4000	
option_A	nvarchar	300	
option_B	nvarchar	300	
option_C	nvarchar	300	
option_D	nvarchar	300	
option_E	nvarchar	300	
pic	nvarchar	50	

5. Table name : structured_question

Description : Store structured questions for an examination.

Table 5.7 Table of strucured_question

Field Name	Data Type	Length	Remarks
exam_id	nvarchar	50	
teacher_id	nvarchar	50	
ques_no	int	4	
instruction	nvarchar	50	
question	nvarchar	4000	
marks	int	4	
sub_ques_qty	int	4	
pic	nvarchar	50	

6. Table name : structured_sub_question

Description : Store sub-structured questions for an examination.

Table 5.8 Table of strucured_sub_question

Field Name	Data Type	Length	Remarks
exam_id	nvarchar	50	
teacher_id	nvarchar	50	
ques_no	int	3	
sub_no	int	2	
sub_ques	nvarchar	300	
marks	int	4	

7. Table name : essay_question

Description : Store essay questions for an examination.

Table 5.9 Table of essay_question

Field Name	Data Type	Length	Remarks
exam_id	nvarchar	50	
teacher_id	nvarchar	50	
ques_no	int	4	
instruction	nvarchar	50	
question	nvarchar	4000	
marks	int	4	
sub_ques_qty	int	4	
pic	nvarchar	50	

8. Table name : essay_sub_question

Description : Store essay's sub-questions for an examination.

Table 5.10 Table of essay_sub_question

Field Name	Data Type	Length	Remarks
exam_id	nvarchar	50	
teacher_id	nvarchar	50	
ques_no	int	4	
sub_no	int	4	
sub_ques	nvarchar	300	
marks	int	4	

5.6 User Interface Design

The user interface design is concerned with the dialogue between a user and the computer system. The user interface design is as important as the functionalities design. Without a user-friendly interface, even a sophisticated system may fail to get user to use the system. There are many human factors that affect the user navigation experience in the Web. As such, these human factors should be studied carefully to design a better user interface.

Today, graphical user interface has gained popularities because it has greatly increased user-friendliness of the computer system. As a web-based system, EPAP applies the elements of the GUI to deliver a easy to use, clean, suitable and yet remarkable interface.

The common styles of GUI that will be used in EPAP are :-

i) Scroll bars - used to navigate the web page and indicate the current position of the cursor relative to the web page.

ii) Frames - window is divided into 2 zones. Each frame can act independently and each frame is defined to serve different purpose.

iii) User interface control. - common GUI control for inputs such as text box, check box and drop-down list

iv) Menu driven strategies - cascading menu and pop-up menu are used to acquire user action selection from a menu of alternatives.

5.6.1 Screen Design

The first login page of the EPAP system screen design is illustrated in Figure 5.9

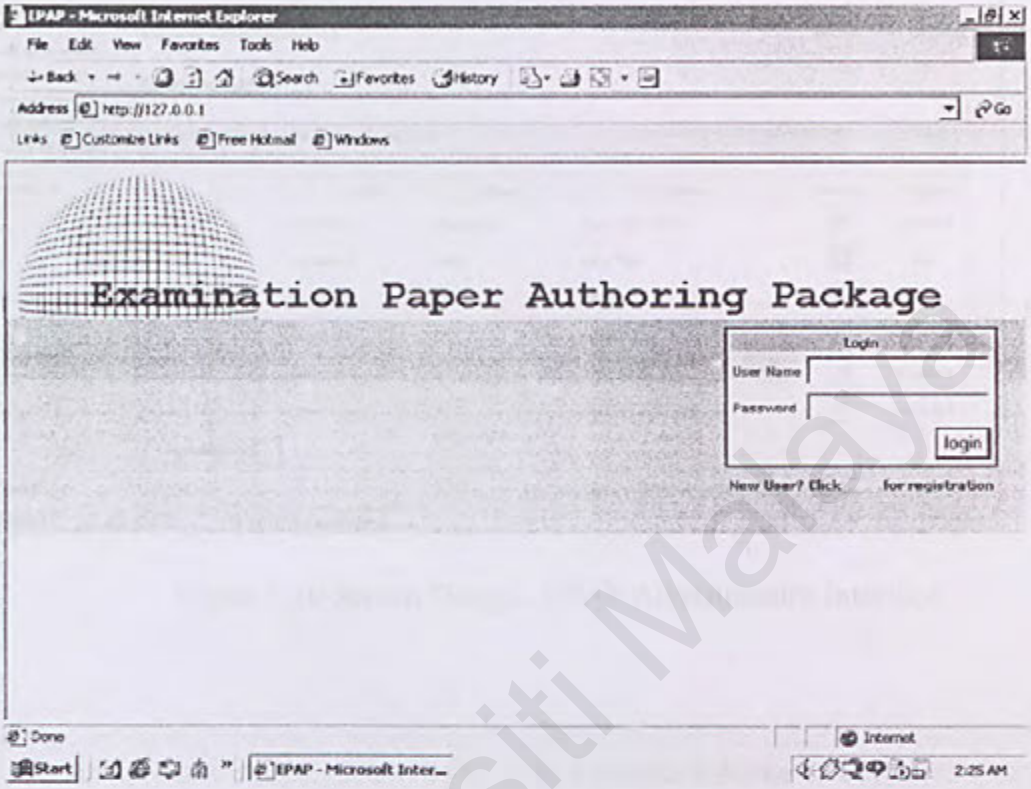


Figure 5.9 Screen Design : EPAP First Page

Once the user is verified, the user can access into the EPAP system. Verified administrator will gain access into the system with interface differs from the lecturer access. The figure 5.10 and figure 5.11 show the draft screen design for both accesses.

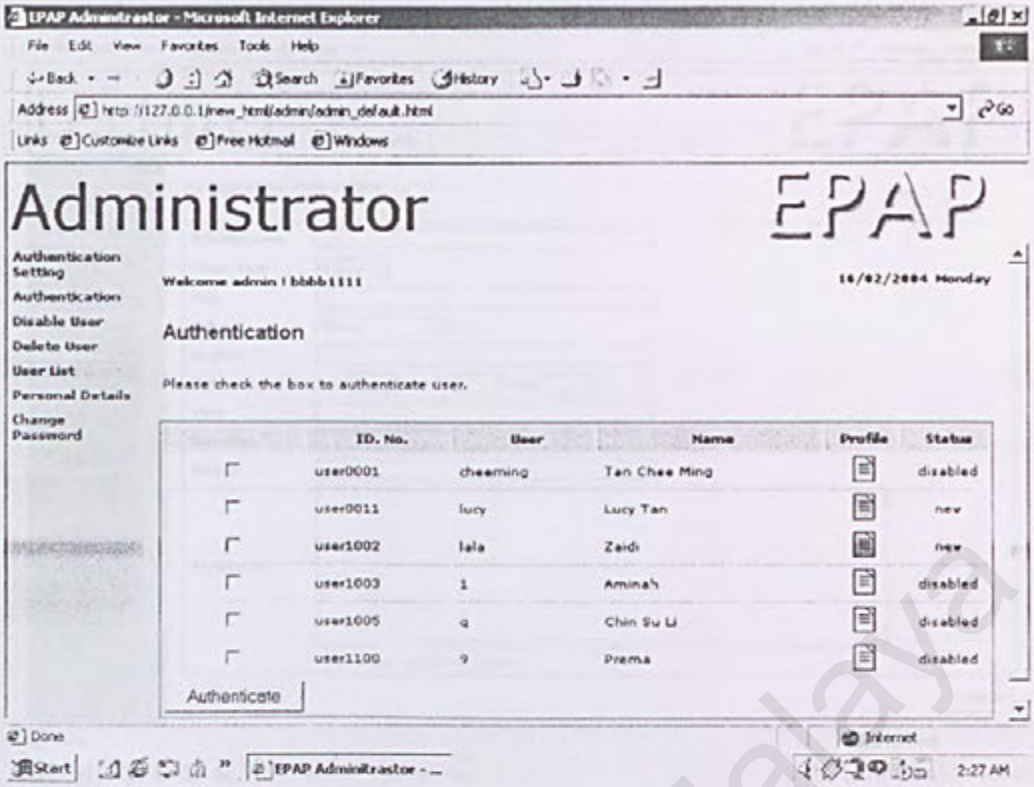


Figure 5.10 Screen Design : EPAP Administrator Interface

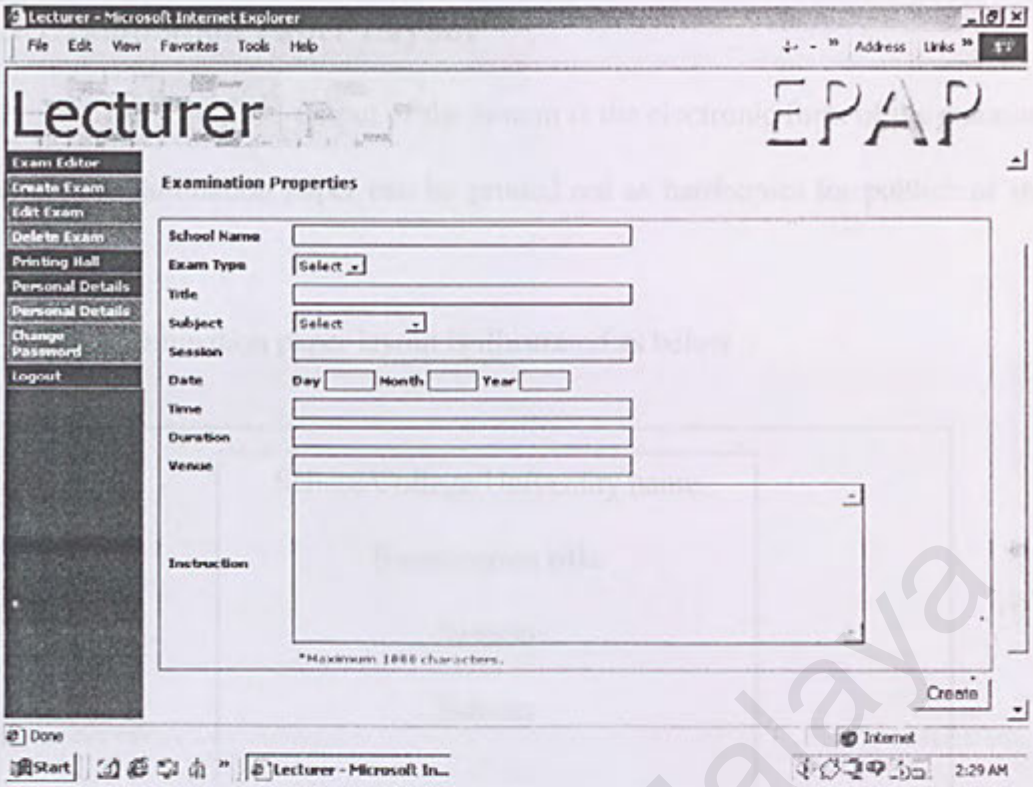


Figure 5.11 Screen Design : EPAP User Interface

5.6.2 Examination Paper Layout

In EPAP, the final output of the system is the electronic form of the examination paper. This examination paper can be printed out as hardcopies for publish or storage purpose.

The examination paper layout is illustrated as below :-

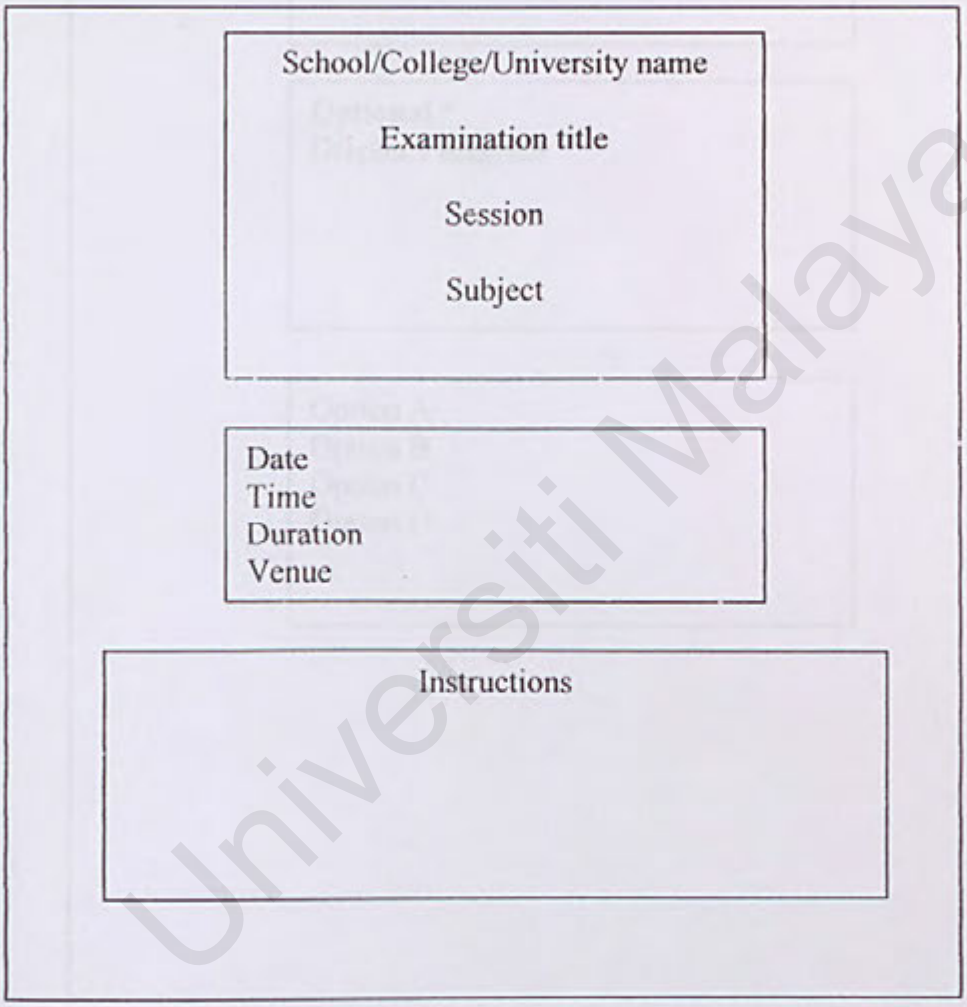


Figure 5.12 Examination Paper Layout : Cover Page

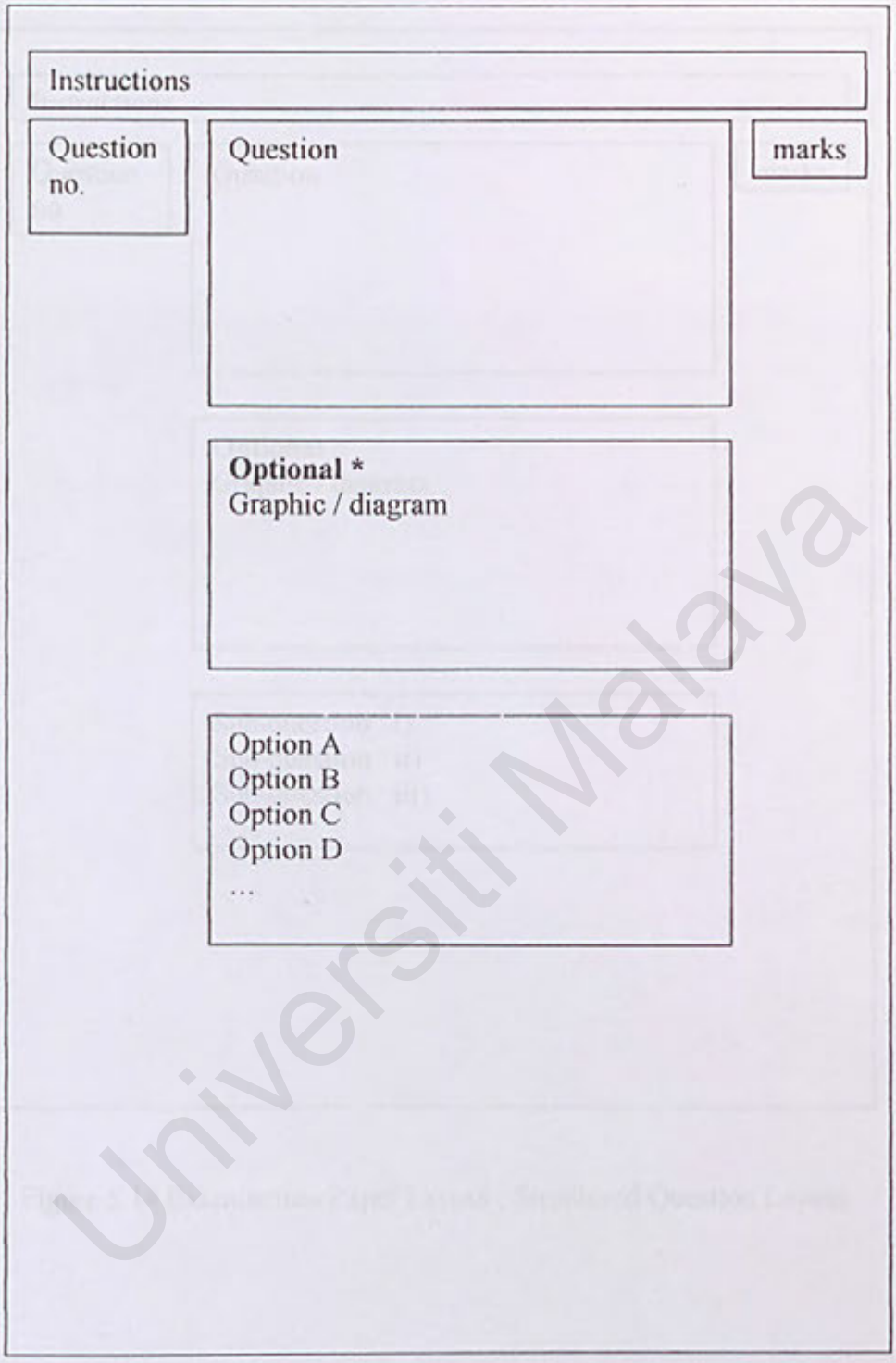


Figure 5.13 Examination Paper Layout : Multiple Choice Question Layout

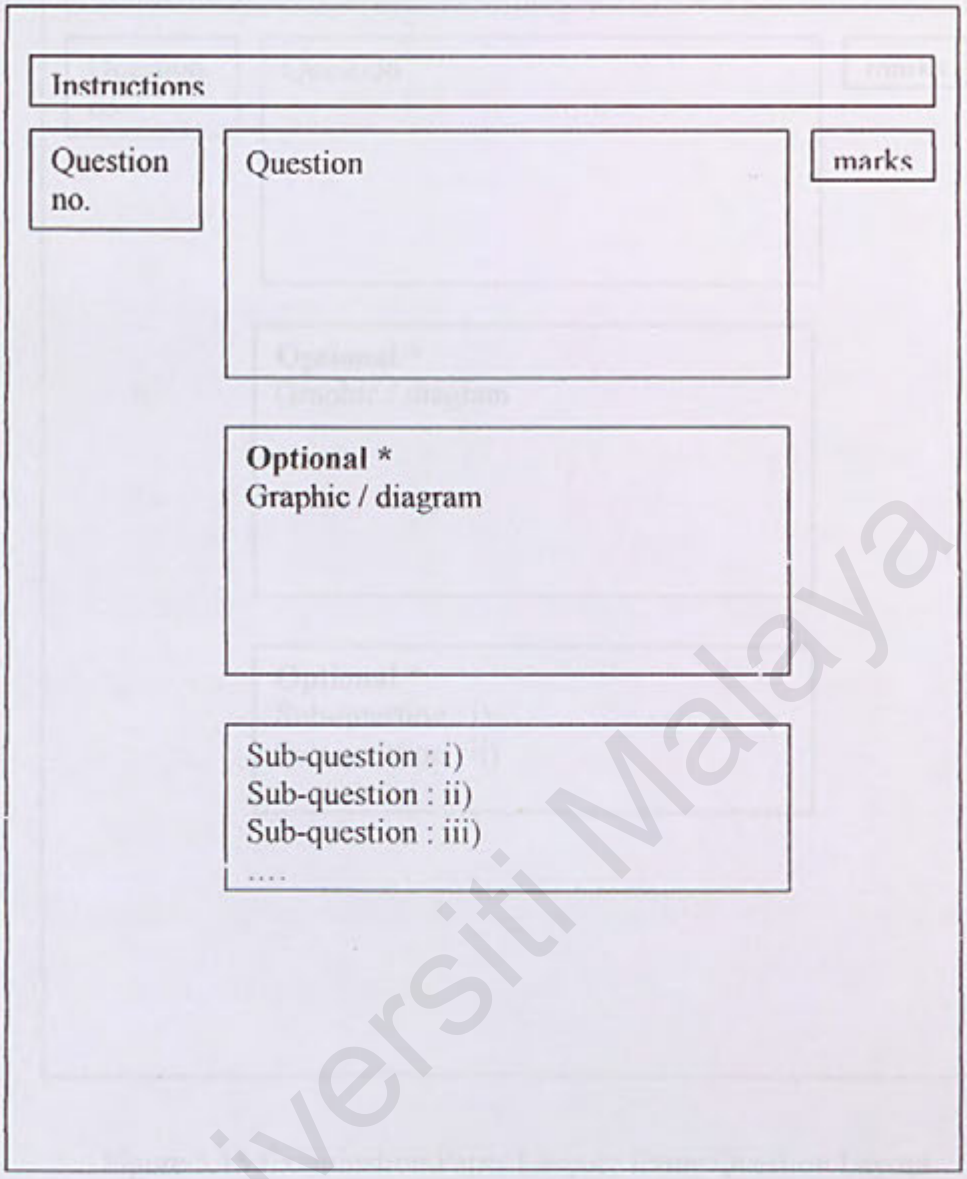


Figure 5.14 Examination Paper Layout : Structured Question Layout

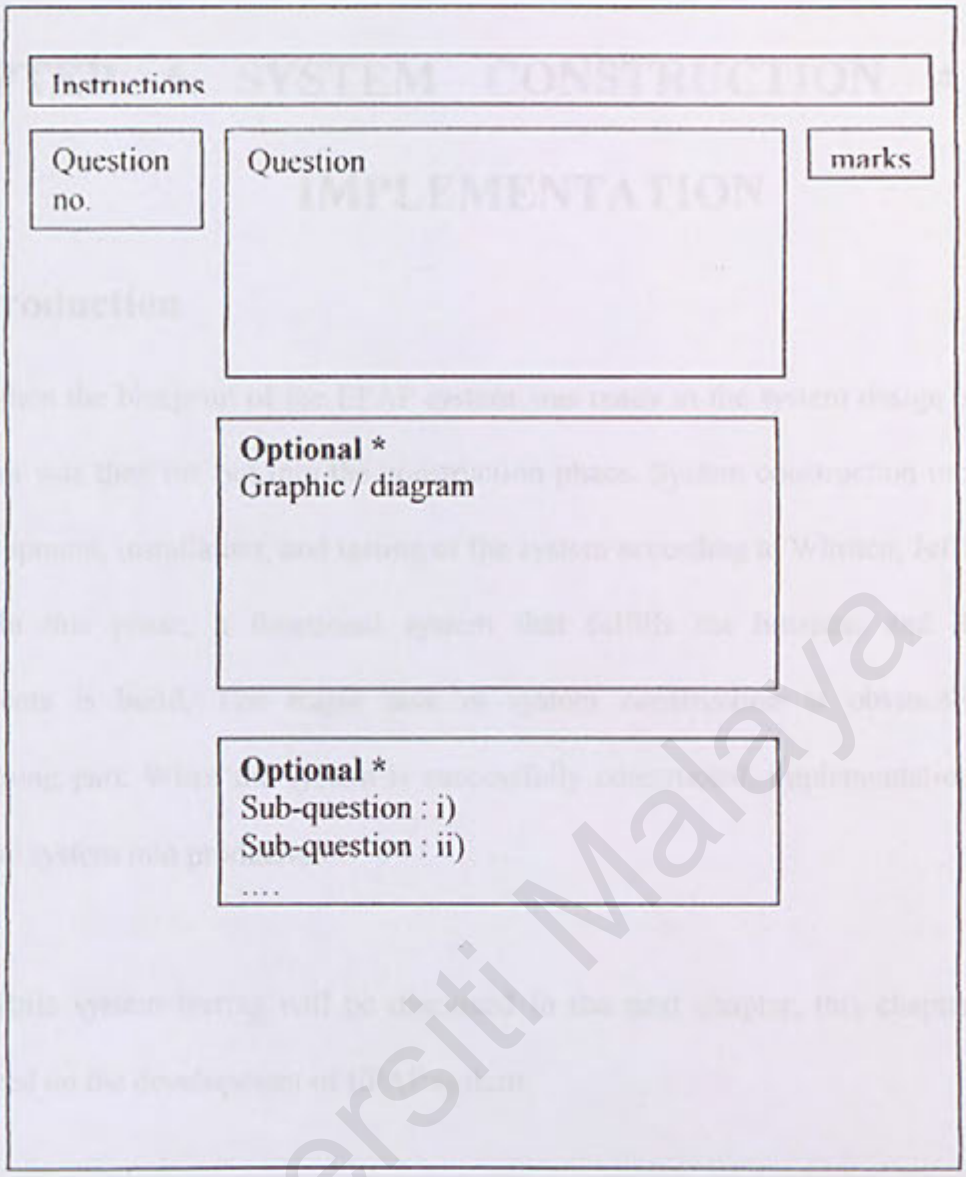


Figure 5.15 Examination Paper Layout : Essay Question Layout

CHAPTER 6 SYSTEM CONSTRUCTION AND IMPLEMENTATION

6.1 Introduction

When the blueprint of the EPAP system was ready in the system design phase, the system was then the put into the construction phase. System construction includes the development, installation, and testing of the system according to Whitten, Jeffrey L. (2002). In this phase, a functional system that fulfills the business and design requirements is build. The major task in system construction is obviously the programming part. When the system is successfully constructed, implementation will deliver the system into production.

While system testing will be discussed in the next chapter, this chapter will emphasized on the development of EPAP system.

6.2 Development Environment

The EPAP system was developed in a suitable environment as it was designed and planned in earlier stage. The web-based system, EPAP, built under the architecture of client – server requires specific hardware and software environment for its construction. The next section will briefly discuss both the hardware and software requirement of the EPAP system.

6.2.1 Hardware Environment

The hardware development environment is the physical platform of construction. A desktop computer with the devices, or peripherals stated as below is needed for the system construction.

- 256 MB RAM
- Intel ®Pentium III 933MHz processor
- 20.5 GB Hard Disk
- Monitor
- Network Interface Card
- Sound Card
- Display Card
- Floppy disk drive
- Keyboard, mouse
- Printer

6.2.2 Software Environment

When the physical platform was ready, the intangible softwares that are needed to develop the EPAP system were then configured and installed. Generally, there were two categories of software environments. First category of software environment was for the purpose of all the designing and documentation tasks. The second category was where the EPAP system will be developed. Table 6.1 shows these two categories of software environment.

Table 6.1 EPAP Development Software Environment

Design and Documentation Tools	
Software	**Description**
1. Microsoft Word.	Documentation.
2. Microsoft Project.	Task Scheduling.
3. Microsoft Visio	Diagram drawing.
Development Tools	
Software	**Description**
1. Windows 2000	Operating system.
2. IIS	Web server.
3. ColdFusion 5.0	Application server.
4. Microsoft SQL Server 2000	Database server.
5. ColdFusion Studio 4.5	Programming workplace.
6. Macromedia Dreamweaver	Programming workplace.
7. Adobe Photoshop 7.0	Interface design workplace.
8. Internet Explorer 6.0	Browser.

6.2.3 Software Configuration And Setting

In general, all the softwares installed for the system development purpose were configured with default setting. However, in the installation of the ColdFusion server, system developer had to provide username and password to administer the development

of ColdFusion application. Figure 6.1 shows the Coldfusion Administrator page in ColdFusion.

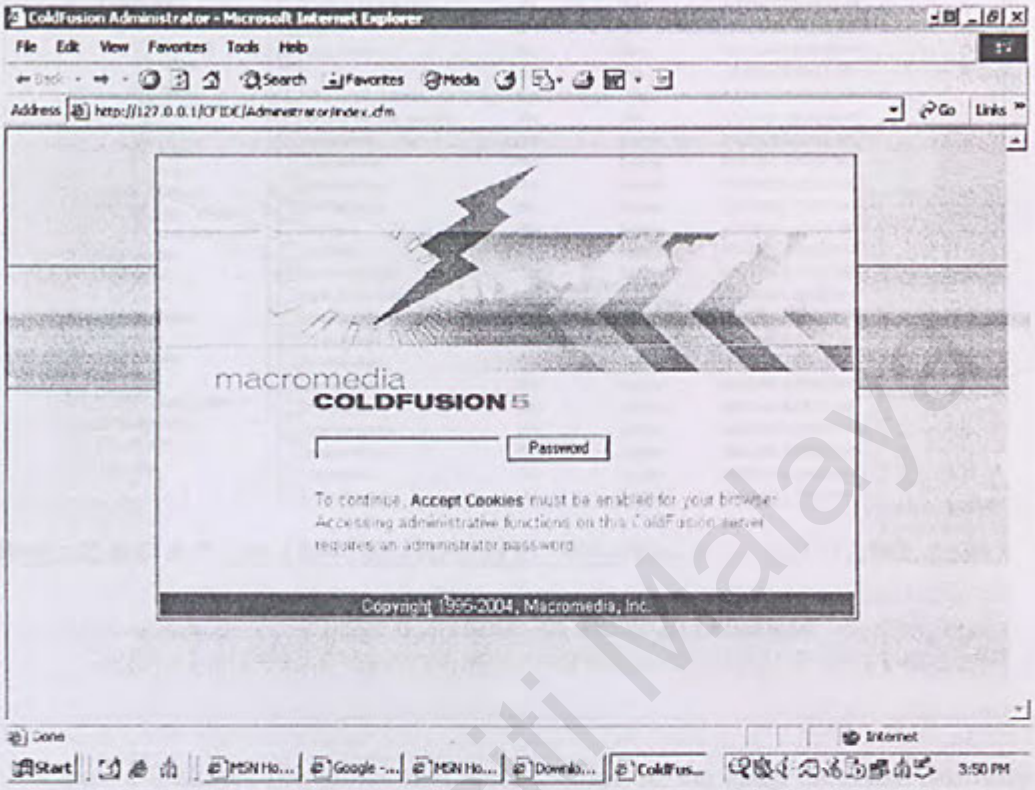


Figure 6.1 ColdFusion Administrator Page

6.3 Database Development

Microsoft SQL server served as back-end database in EPAP system. A new database named as *epap* was created in the console root under the SQL Server Group where the server located. New tables such as admin_info, teacher_info, exam and so on were created as designed in the system design phase.

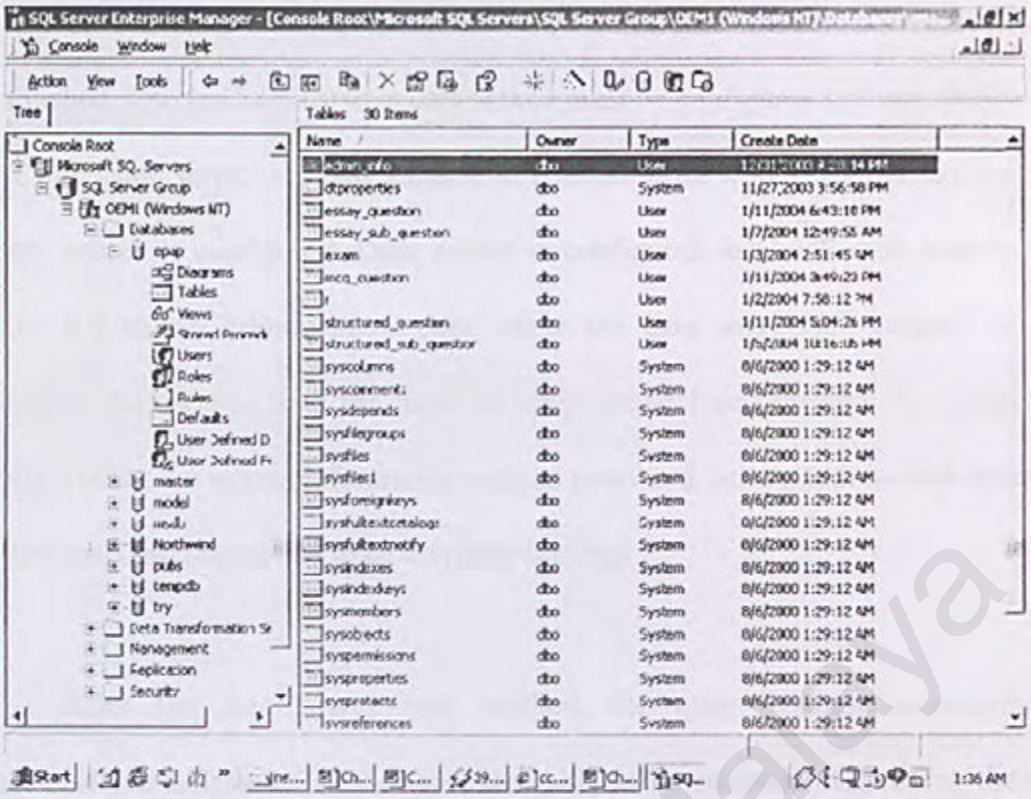


Figure 6.2 Tables in the *epap* Database

Figure 6.2 shows the tables that were created in the *epap* database. Initially, the each table was created according to the original design. However, during the course of the development, the fields in the table had been modified, added or deleted as new requirements were discovered and adjustment needed to be done to cope with unforeseen situation in the design phase.

For example to authenticate a new user, the system needs to recognize the user as 'new' so that system administrator can authenticate the user later on. Hence, a new field named as status was added to the table of teacher_info.

To work with the *epap* database in SQL server, the database connection must be established first. In ColdFusion, a data source must be configured for each database file, the ColdFusion server will only capable of communicate with a specific database when a data source is configured. Data source is configured in ColdFusion Administrator. Figure 6.3 shows Administrator page where the data source are created. In EPAP system, a data source with the name of epap_connect was created. To complete the configuration, the setting information such as password, server address and database to be connected and so on had to be correctly inserted.

After the data source was verified, the *epap* database connection was successfully established. The database was able to be communicated using the CFML expression. An example of CFML to communicate with the table of teacher_info in *epap* database is shown below.

```
<cfquery name="list" datasource="epap_connect">
    select *
    from teacher_info
</cfquery>
```

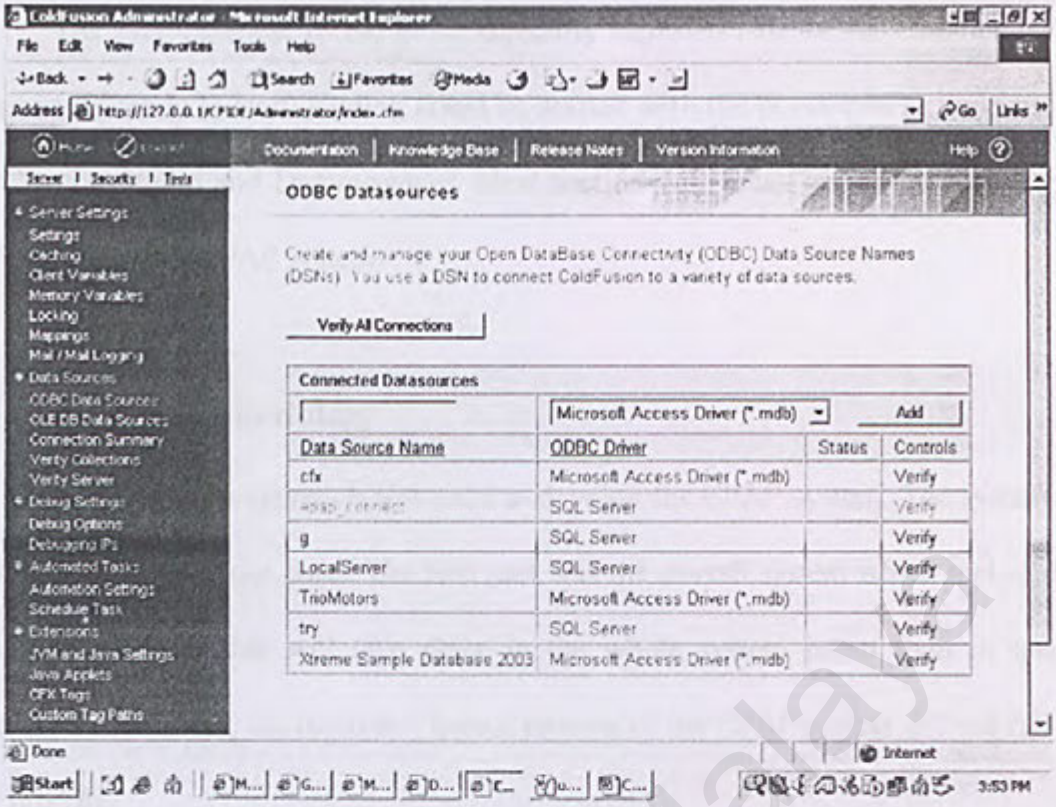


Figure 6.3 Data Source Configuration in Administrator

6.4 Application Development

During this stage, the system design was realized as a set of programs or program unit. Coding translated all algorithms and processes in the design into ColdFusion Markup Language instructions that served as the foundation of the system functions.

As a web-based system, EPAP had a home directory that served as the central location for all published pages. EPAP system's home directory was C:\Inetpub\wwwroot. All the system files were located in this directory to be published.

The establishment of the home directory signified that the development of the system was ready to start. Coding could be started with the development tools such as ColdFusion Studio and Dreamweaver. Next section will focus on the methodology of coding used in the EPAP system.

6.4.1 Coding Methodology

A top – down approach was used to develop the EPAP system. The system was divided into three major parts. The first part was the overall system which included the general algorithms that will take place in the whole system rather than in specific module. For instance, the login and logout process of the EPAP system did not fall into any module.

The second part was the Administrator module. This module consists of several functions that allowed the administrator to authenticate new user, to disable inactive user and to delete the user account.

The third part was User module. This module was further broke down into three sub-modules, namely Personal Details, Exam Editor and Printing Hall. Exam Editor allowed user to create exam, edit exam and delete exam. In Printing Hall, exam that was created would be displayed.

Each of these modules was developed separately in sequence and finally integrated together. The following session will briefly explain the coding in the three major modules.

6.4.2 CFML The Language

ColdFusion server reads and interpret instructions from CFML to perform specific operations. Generally, the basics and principles of CFML are discussed in this section.

CFML consists of two primary language elements: tags and functions. Tags are used to perform operations such as accessing a database. Functions can return data and do other operations like retrieving the system date. In ColdFusion coding, tags and functions are used frequently.

Similar to HTML tags, ColdFusion tags are enclosed in angle brackets and often have a start and end tag. The start tag encloses the tag name in brackets, and the information processed by ColdFusion is placed between the start and end tag, for example :-

```
<tagname>
info to be processed ...
</tagname>
```

In ColdFusion, <cfset> is used to declare variable. The syntax example is

shown as below :-

<cfset variable_name = value>

To return the value of a variable, the variable name must be surrounded with pound signs (#) and place the variable name between the cfoutput start and end tags.

6.4.3 Coding : Overall System – Login and Logout Processes

EPAP first user interface requires existing user to login in order to gain access into the system. New user is required to register first, so that the system administrator can later on authenticate their access. Registered user's details will be stored in the table of teacher_info in the database. The coding will then instruct to retrieve the user details to verified the user.

Files involved in the login and logout process are shown in Table 6.2.

Table 6.2. Main Files in Login and Logout Process

No.	File Name	Description
1.	login.cfm	Get user username and password.
2.	login_process.cfm	Verify user and redirect user to their module.
3.	application.cfm	Session management.
4.	logout.cfm	Allow user to logout and clear session variable.

Figure 6.4 shows the coding sample of login and verification process of EPAP system. In the next example, Figure 6.5 shows the coding of logout process. Statements within the <!--- and ---!> tags are comments of the coding.

```
<!--- Get all records from the database that match this user credentials --->
<cfquery name="qVerify_teacher" datasource="epap_connect">
  select teacher_username, teacher_password,status,teacher_id
  from teacher_info
  where teacher_username='#username#' and teacher_password='#password#'
</cfquery>

<cfquery name="qVerify_admin" datasource="epap_connect">
  select admin_username, admin_password,admin_id
  from admin_info
  where admin_username='#username#' and admin_password='#password#'
</cfquery>

<cfif qVerify_teacher.RecordCount and qVerify_teacher.status is 'authenticated'>
<!--- User has logged in correctly, set session.allowin value to "True" and redirect
to User module --->
        <cfset session.allowin = "True">
        <cfset client.username="#qVerify_teacher.teacher_username#">
        <cfset client.id="#qVerify_teacher.teacher_id#">
  <script>
     alert("Welcome user, you have been successfully logged in!");
     top.self.location.href="new_html/lecturer/teacher_default.html";
  </script>

<cfelseif qVerify_admin.RecordCount >
 <!--- User has logged in correctly, set session.allowin value to "True" and redirect
to Administrator module --->
        <cfset session.allowin = "True">
        <cfset client.username="#qVerify_admin.admin_username#">
        <cfset client.id="#qVerify_admin.admin_id#">
  <script>
     alert("Welcome user, you have been successfully logged in!");
     top.self.location.href="new_html/admin/admin_default.html";
  </script>

<cfelse>
  <!--- this user did not log in correctly, alert and redirect to the login page --->
  <script>
     alert("Your credentials could not be verified, please try again!!!");
     self.location="Javascript:history.go(-1)";
  </script>
</cfif>
```

Figure 6.4 Login Process Coding Sample

```
<!--- Clear all session variable --->
<cfscript>structclear(session);</cfscript>
```

Figure 6.5 Logout Process Coding Sample

6.4.4 Coding : Overall System – User Registration

Before a user can use the EPAP system, he or she must register first and then wait for the administrator authentication. User must provide the secret or confidential register key provided by the administrator in order to register. User with invalid or wrong register key cannot be registered.

```
<cfquery name="oldkey" datasource="epap_connect">
select * from admin_info
where admin_id='#client.id#'
</cfquery>

<cfif #form.old_key# neq #oldkey.register_key#>
<cfoutput><font class="attention2">Invalid register key.</font></cfoutput>
……..
<cfelseif #form.key1# neq #form.key2# >
……..
<cfoutput><font class="attention2">New register keys do not match.</font></cfoutput>
……..
<!---If new register keys are matched and old register key is correct, update register key--->
<cfelseif #form.key1# eq #form.key2# and #form.old_key# eq #oldkey.register_key#>
<cfquery name="setkey" datasource="epap_connect">
update admin_info
set register_key='#form.key1#'
where admin_id='#client.id#'
</cfquery>
<cfoutput><font class="attention2">Register Key updated.</font></cfoutput>
```

Figure 6.6 User Registration Coding Sample

Files involved in the user registration process are shown in Table 6.3.

Table 6.3. Main Files in User Registration

No.	File Name	Description
1.	user_registration1.cfm	Get user information and register key.
2.	register.cfm	Verify user and redirect user to the login page if registration success.

6.4.5 Coding : Administrator Module

In this module, Administrator is allowed to view a list of user with different status. Administrator can check the box of the user whom he or she intends to authenticate, disable or delete. Besides, Administrator may also edit his or her own personal details, and change password. The main files involved in this module are listed in Table 6.4.

Table 6.4 Main Files in Administrator Module

No.	File Name	Description
1.	admin_main.cfm	List new and disabled users.
2.	authenticate.cfm	Authenticate users.
3.	disable.cfm	List authenticated users
4.	disable_pro.cfm	Disable users.
5.	delete_acc.cfm	List disabled users.
6.	delete_acc_pro.cfm	Delete users.
7.	admin_details.cfm	Display administrator personal details.

8.	user_list.cfm	List all users.
9.	a_setting.cfm	Set register key.
10.	a_setting_pro.cfm	Update register key.
11.	admin_edit.cfm	Edit administrator personal details.
12.	change_password.cfm	Get old and new password
13.	change_password_pro.cfm	Update password.

In Figure 6.7, the coding example shows the authentication process where the status of user is updated to 'authenticated'. The authenticated user will be able to gain access into the system with this status.

```
<cfloop index="count" from="1" to="#form.rec_count#">

<cfif isdefined('form.authenticate_#count#')>
<!---If the user's box is checked, update their status--->
<cfset id = #evaluate('form.authenticate_#count#')#>
<cfquery name="set_status" datasource="epap_connect">
update teacher_info SET status='authenticated' where teacher_id='#id#'
</cfquery>
</cfif>

</cfloop>
```

Figure 6.7 User Authentication Coding Sample

6.4.6 Coding : User Module

There are three major sub-modules under User modules. The coding of each of these sub-modules will be discussed below.

i) **Exam Editor**

The Exam Editor is further broke down into 3 sections, namely Create Exam, Edit Exam and Delete Exam.

A) Create Exam

This section allows user to create an exam paper. The default page of the this section is Examination Properties where user insert the details of the exam paper. User is required to choose the type of exam the exam paper belongs to. The exam types are Quiz, Test, and Exam. By clicking the 'Create' button. An exam is created with an unique Exam ID and user can now choose to author a multiple choice question, structured question or essay question paper. The Exam ID is auto-generated. User can then begin to create questions upon the selection of the question type of multiple choice question, structured question or essay question.

Table 6.5 shows main files in this section.

Table 6.5 Main Files in Create Exam

No.	File Name	Description
1.	exam_properties.cfm	Get input of examination properties details.
2.	create_exam.cfm	Create exam with an unique ID.
3.	mcq.cfm	Get total marks and total questions from user.
4.	mcq_pro.cfm	Update table of exam in database.
5.	mcq_start.cfm	Get input of multiple choice question.

6.	mcq_start_pro.cfm	Insert into table of mcq_question.
7.	str.cfm	Get total marks and total questions from user.
8	str_pro.cfm	Update table of exam in database and get sub-question quantity from user.
9.	str_start.cfm	Get input of structured question.
10.	str_start_pro.cfm	Insert into table of structured_question and structured_sub_question.
11.	ess.cfm	Get total marks and total questions from user.
12.	ess_pro.cfm	Update table of exam in database and get sub-question quantity from user.
13.	ess_start.cfm	Get input of essay question.
14.	ess_start_pro.cfm	Insert into table of essay_question and essay_sub_question..

In Figure 6.8, some coding samples of the creation of exam are shown.

```
<cfif isdefined('form.create_exam')>

……...
<!---create exam_id--->
……..
……..
……..
<cfif #no# LT 10>
<cfset temp=#Insert("#char#","0",0)#>
<cfset temp2=#Insert("#temp#","0",0)#>
<cfset temp3=#Insert("#temp2#","0",0)#>
<cfset final=#Insert("#temp3#","#no#",0)#>

<cfelseif #no# GTE 10 and #no# LT 100>
<cfset temp=#Insert("#char#","0",0)#>
<cfset temp2=#Insert("#temp#","0",0)#>
<cfset final=#Insert("#temp2#","#no#",0)#>

<cfelseif #no# GTE 100 and #no# LT 1000>
<cfset temp=#Insert("#char#","0",0)#>
<cfset final=#Insert("#temp#","#no#",0)#>

<cfelseif #no# GTE 1000 and #no# LT 10000>
<cfset final=#Insert("#char#","#no#",0)#>
</cfif>

<cfset exam_id=#final#>

<!--- insert into exam table--- >
<cfquery name="create_exam" datasource="epap_connect">
insert into exam(rec_no,exam_id, exam_title,subject, subject_code, exam_time,
exam_date, exam_duration, exam_venue, exam_session, school_name, instruction
exam_type, teacher_id)
values(#rec#,'#exam_id#','#form.title#','#form.subject#','#form.subj_code#','#form.
time#','#date#','#form.duration#','#form.venue#','#form.e_session#','#form.s_name
#','#form.ins#','#form.e_type#','#id#')
</cfquery>
……..
……..
……..
</cfif>
```

Figure 6.8 Examination Creation Coding Sample

In the Create Exam section, there is a feature which allows user to include image in the questions to enrich the examination paper's content. To upload an image, encryption must be included in the from, for instance : *enctype="multipart/form-data"*. Figure 6.9 shows the sample coding of insert an image file into the table in database.

```
……
……
……
<cfif #form.pic# neq ">
<!--- upload image file to the home directory--- >
<cffile action="upload"
   destination="c:\Inetpub\wwwroot\image"
   nameConflict="makeunique"
   fileField="form.pic">
        <cfset uploaded = #listLast(file.serverFiie, '\')#>

<cfelse>
<cfset uploaded="">
</cfif>
<!--- insert into the table of structured_question--->
<cfquery name="insert_q" datasource="epap_connect">
insert into
structured_question(teacher_id,exam_id,ques_no,question,instruction,marks,sub_q
ues_qty,pic)
values('#client.id#','#eid#','#i#','#form.ques#','#form.ins#','#form.marks#','#form.s_
qty#','#uploaded#')
</cfquery>
```

Figure 6.9 Image Insertion Coding Sample

Another feature in the EPAP system is the ability to show the remaining total marks each time a question is created. If the marks for a question

exceed the remaining total marks, user will be alerted with a prompt message box. Figure 6.10 shows the mechanism of this feature.

```
.....
<!--- search for total marks of a particular exam--->
<cfquery name="total_m" datasource="epap_connect">
select *
from exam
where teacher_id='#client.id#' and exam_id='#eid#'
</cfquery>
<!--- search for marks of questions in a particular exam--->
<cfquery name="added_marks" datasource="epap_connect">
select *
from structured_question
where teacher_id='#client.id#' and exam_id='#eid#'
</cfquery>
<cfif #total_m.total_marks# eq "">
<cfset t=o>
<cfelse>
<cfset t=#total_m.total_marks#>
</cfif>
<cfset a=0>
<cfloop query="added_marks">
<cfif #added_marks.marks# eq "">
<cfset a=0>
<cfelse>
<!--- add up the marks of the questions just created--->
<cfset a=a+#added_marks.marks#>
</cfif>
</cfloop>

<!---count total marks remaining by subtracting the marks of the questions that just created with total marks--->
<cfset remain=#t#-#a#>

<cfoutput>Total Marks Remaining</cfoutput>
<cfoutput><font class="attention2">#remain#</font></cfoutput>
```

Figure 6.10 Calculate for Remaining Marks Coding Sample.

B) Edit Exam

An exam created may subject to modifications and changes before it has become the final piece of work. In this section, all exam created previously will be listed down. User can edit the examination properties and questions in particular exam. User may delete questions as well. If user discovers the necessary to add more questions to that exam, this section also provides a room for the requirement. Major files that are involved in the edition of an exam paper are listed in Table 6.6.

Table 6.6. Major Files in Edit Exam

No.	File Name	Description
1.	edit_exam.cfm	List all exam.
2.	edit_e_p.cfm	Display exam properties of particular exam.
3.	edit_e_p_pro.cfm	Allow user to edit exam properties and update table of exam in database.
4.	edit_mcq.cfm	List all question according to question type of particular exam such as mcq, structured and essay question.
5.	edit_mcq_pro.cfm	Update table of mcq_question, structured_question, structured_sub_question, essay_question, or essay_sub_question according to the question type of particular exam.
6.	del_mcq.cfm	Delete question from table of mcq_question, structured_question, structured_sub_question, essay_question, or essay_sub_question according to the question type of particular

		exam.
7.	add_mcq.cfm	Get total marks and total questions intended to add from user.
8.	add_mcq_pro.cfm	Update total of question in table of exam in database.
9.	add_mcq_start.cfm	Get input of multiple choice question from user.
10.	add_mcq_start_pro.cfm	Insert into table of mcq_question.
11.	add_str.cfm	Get total marks and total questions intended to add from user.
12.	add_str_pro1.cfm	Update table of exam in database.
13.	add_str_pro2.cfm	Get sub-question quantity from user.
14.	add_str_start.cfm	Get input of structured question from user.
15.	add_str_start_pro.cfm	Insert into table of structured_question and structured_sub_question.
16.	add_ess.cfm	Get total marks and total questions intended to add from user.
17.	add_ess_pro1.cfm	Update table of exam in database.
18.	add_ess_pro2.cfm	Get sub-question quantity from user.
19.	add_ess_start.cfm	Get input of essay question from user.
20.	add_ess_start_pro.cfm	Insert into table of essay_question and essay_sub_question.

C) Delete Exam

This section allow user to delete the entire exam paper of particular Exam ID. The coding can be seen as in Figure 6.11. Major files that involved in this section are shown in Table 6.7.

```
<!---if the exam is mcq question type--->
<cfif #t# eq 1>
<cfquery name="delete" datasource="epap_connect">
delete exam
where exam_id='#eid#' and teacher_id='#client.id#'
</cfquery>
<cfquery name="delete" datasource="epap_connect">
delete mcq_question
where exam_id='#eid#' and teacher_id='#client.id#'
</cfquery>
</cfif>

<!---if the exam is structured question type--->
<cfif #t# eq 2>
<cfquery name="delete" datasource="epap_connect">
delete exam
where exam_id='#eid#' and teacher_id='#client.id#'
</cfquery>
<cfquery name="delete" datasource="epap_connect">
delete structured_question
where exam_id='#eid#' and teacher_id='#client.id#'
</cfquery>
<cfquery name="delete" datasource="epap_connect">
delete structured_sub_question
where exam_id='#eid#' and teacher_id='#client.id#'
</cfquery>
</cfif>

<!---if the exam is essay question type--->
<cfif #t# eq 3>
<cfquery name="delete" datasource="epap_connect">
delete exam
where exam_id='#eid#' and teacher_id='#client.id#'
</cfquery>
<cfquery name="delete" datasource="epap_connect">
delete essay_question
where exam_id='#eid#' and teacher_id='#client.id#'
</cfquery>
<cfquery name="delete" datasource="epap_connect">
delete essay_sub_question
where exam_id='#eid#' and teacher_id='#client.id#'
</cfquery>
</cfif>
```

Figure 6.11 Delete Exam Coding Sample.

Table 6.7. Major Files in Delete Exam

No.	File Name	Description
1.	del_exam.cfm	List all exam.
2.	del_exam_pro.cfm	Delete all records in table of exam. Delete all records in table of mcq_question, structured_question and structured_sub_question or essay_question and essay_sub_question according to Exam ID.

ii) **Printing Hall**

Printing Hall is where all papers will be listed under three examination types, namely Quiz, Test and Exam. By clicking on the Exam ID, the user is able to see and print the Examination Properties of the exam paper. Examination Properties usually serves as the cover or first page of the examination paper. 'Proceed to Questions' button will take user to the questions page in an organized manner. User may also print out the questions. Table 6.8 is a list of major files in this section with the descriptions.

Table 6.8 Major Files in Printing Hall

No.	File Name	Description
1.	printing.cfm	List all exam under categories of Quiz, Test, and Exam.
2.	printing_pro.cfm	Display Examination Properties of particular exam. Allows printing and redirect to questions page.

3.	printing_pro_e_p.cfm	Print Examination Properties page of particular exam.
4.	printing_pro_q.cfm	Display question of particular exam in proper manner. Allows printing.
5.	printing_mcq_ready.cfm	Print multiple choice questions page of particular exam.
6.	printing_str_ready.cfm	Print structured questions page of particular exam.
7.	printing_ess_ready.cfm	Print essay questions page of particular exam.
8.	printing_mcq_r_all.cfm	Print all pages of the MCQ question paper.
9.	printing_str_r_all.cfm	Print all pages of the structured question paper.
10.	printing_ess_r_all.cfm	Print all pages of the essay question paper.

iii) Personal Details

Similar to the Administrator module, in this sub-module user is allowed to change personal details and password as well. The coding involved is updating the table from the form which is similar to the coding explained above. Major files that are involved in this section are stated in Table 6.9.

Table 6.9 Major Files in Personal Details

No.	File Name	Description
1.	teacher_details.cfm	Display all user's personal details.
2.	teacher_edit.cfm	Update user's personal details.
3.	change_password.cfm	Get old and new password
4.	change_password_pro.cfm	Update password.

CHAPTER 7 SYSTEM TESTING AND DEBUGGING

7.1 Introduction

System testing is vital in the development of all information systems. It establishes and reveals the existence of defects of a system and thereby signifies the need of debugging. Debugging is essential to locate and to remove and rectify defects. As the correctness of the EPAP system is the major concern of the user, system testing had been carried out to ensure its reliability.

The goal of defect testing is to expose latent defects in a software system. (Sommerville, Ian, 2000) As such, it is necessary to cause the system to perform incorrectly, hence exposes the defects. On the other hand, defects can exist in numerous ways and sometimes beyond the cognition of the programmer and tester. Thus, different techniques and strategies are used to uncover the defects from different angles. EPAP system testing techniques are covered in the next section.

7.2 Testing Techniques

System testing commonly falls into two categories; White-box testing and Black-box testing. Both these techniques are used in EPAP system testing. Because the nature of each segment of coding is different, different techniques were used in the process of testing according to their characteristics.

7.2.1 White-box Testing

White-box testing is an approach to testing where the test are derived from the knowledge of the software's structure and implementation according to Sommerville, Ian 2000. In this approach, the coding of small program units such as sub-routines are analyzed and test cases are then derived with the knowledge of the structure.

7.2.1.1 Compound Condition Testing

In EPAP system, there are many segments that deal with compound conditions. The most frequently used compound conditions are 'if-else' conditions and nested 'if-else'. Nested compound condition increases the complexity of the processing of the coding and it has become the most common cause of defects. Compound Condition Testing had been carried out using test case with the opposite input values or and values outside the compound conditions to trace the loopholes.

7.2.1.2 Path Testing

The objective of this approach is to ensure that each independent program is executed at least once. Each branch in a conditional statement (if-else or case) represents a separate path. The Path Testing test case made sure both the true and false branches of all conditions must be executed in EPAP system.

7.2.1.3 Data Flow Testing

The data flow testing test the correctness of the data being passed in the execution. Variables were checked and traced to avoid situation where they had been declared but not used or not initialized. It is to avoid the data dependencies caused by sequences of data manipulation.

In EPAP system, there were different variables including global and local variables that were used in different units. These variables were tested with a series of input values or initiated values from the other data flow that where it received. The outputs were then analyzed to detect errors.

7.2.1.4 Loop Testing

Loop testing is very important to prevent infinite loop that will lead to system failure. Test cases are created using boundary values to test the looping of single loop and concatenated loop so that the looping sequences and frequencies are as the result that was expected.

7.2.2 Black-box Testing

Contrary to the White-box testing, Black-box tests are not derived from knowledge of the software's structure but the system functionality. Black – box testing study the inputs and related outputs in EPAP system.

7.2.2.1 Error Guessing

Error Guessing is based on heuristic knowledge. High probability cause of errors or any suspected inputs was used to create test case. If the outputs do not fall into any categories that were predicted, then the test has successfully detected a defect in the system.

7.2.2.2 Boundary Value Analysis

This technique is based on the assumption that computer programs normally behave in a comparable way for all members of a class of input. The analysis will focus on the values inside the boundary, outside the boundary and on the boundary.

7.3 Testing Strategy

EPAP system used a set of strategies to test for defects. These strategies are unit testing, module testing and system testing.

7.3.1 Unit Testing

Individual components are tested to ensure correctness individually without other system component. An example of unit testing is shown below.

Unit : Change Password

Example of Unit Testing : If the password given by the user is verified, and the new password matches with the password confirmed by user, update the user password. Otherwise, error message will be prompted, password cannot be updated.

Test case 1 : Existing password incorrect, new password and confirmed password match. Error message is prompted : Invalid password.

Test case 2 : Accurate existing password, new password and confirmed password do not match. Error message is prompted: New passwords do not match.

Test case 3 : Accurate existing password, new password and confirmed password match. Message is prompted : Password updated.

As program develops, a unit grows in the length of the coding. A unit constitute of many different segments that interrelated. These segments were tested individually with the Black-box testing and White-box testing techniques discussed above. An example of an more complex unit is shown as below :-

Unit : Add sub total marks of a structured question.

Example of Unit Testing : Add the sub total marks and check the total with the question's marks. If the sub total marks are

7.3.3 Integration Testing

The integration testing aimed to ensure the interaction between individual program components, as well as the interaction among each module work correctly. An incremental approach was used in system integration testing to observe any abnormal problems and to locate errors in the EPAP system. An example of integration testing is shown as below :-

Sub module : Create Exam, Edit Exam and Delete Exam

Example of Integration Testing : An created exam will appear in the Edit Exam and the Delete Exam; an deleted exam will not appear in Edit exam.

Test case 1 : Exam of any exam type and any question type is created in Create Exam. Check in the Edit Exam and Delete Exam whether the same Exam appears.

Test case 2 : Delete the exam in Delete Exam. Check in the Edit Exam whether the same Exam appears.

7.3.4 System Testing

System testing tested the EPAP as a whole functional system. Test cases were designed in such way with the presumption that user is novice. In this way, the invalid input or errors were more realistic and more likely to be unveiled because it is closer to the errors in actual operation.

System testing makes sure the system was constructed and tested in isolation works properly when they are integrated into the total system. Besides, the test case also validated that the system meets its functional and non- functional requirements.

7.4 Debugging And Error Handling

System testing only reveals the existences of the errors, programmers need to locate the errors and fix the errors through the process of the debugging. In EPAP system, there are a number of strategies of debugging and error handling in order to ensure the correctness of the system. These strategies are explained below.

7.4.1 Safeguarding

Prevention is better than curve. It is better to make sure the input and source of data are valid before they are processed rather than giving chances to all forms of data to generate unexpected errors later. It because errors may occurs in many ways. Programmers may find it difficult to figure out the cause of the errors as programs develop larger. Safeguarding in this case play a role to filter out erroneous data or variable.

In EPAP system, safeguarding is done using Javascript. Javascript validate the input data from user. If the data is not in the form as expected, user will be alerted with error message. Process will not be continued until the valid data is inserted. Below is an example of Javascript validation.

```
<script language="javascript">
function check_no(){

x=parseInt(document.forms[0].marks.value);
y=parseInt(document.forms[0].remain_marks.value);

if (IsNumeric(document.forms[0].marks.value) == false)
    {alert("Please insert numeric value only for marks!");
     return false;}

 if (x>y)
    {alert("Marks exceed the remaining marks!");
     return false; }

else return true;
 }
</script>
```

Figure 7.1 Javascript Form Validation Sample

7.4.2 Error Fixing

Other unavoidable errors must be fixed. Errors are fixed step by step carefully. In general these are :-

1. Locate the error.
2. Study the data flow and program flow where the error occurs.
3. Take out or isolate the segment of code to test separately.
4. Refer to other resources or references with guidance to similar error or problem.
5. Fix it and put it back to the original location.
6. Make necessary notes for reference in future.

CHAPTER 8 SYSTEM EVALUATION AND FUTURE ENHANCEMENT

8.1 Problems and Solutions

To complete the system of EPAP was not an easy task. It was challenging because everything was start from scratch. Time was spent to explore the field of knowledge that was not learnt before in the university in order to solve numerous problems arise during the development and implementation of the system. Problems encountered in the course of the development are discussed below.

8.1.1 Lack Of Knowledge in Application Server, Web Server and SQL Server

Due to the lack of knowledge in the application server, ColdFusion 5 and the web server, IIS, many problems occurred in the beginning stage of the system development. The problems related to the Coldfusion server and IIS server are stated as the following :-

Problem 1 : The ColdFusion page was unable to be displayed in the localhost after the IIS and the ColdFusion were installed in the computer.

Solution 1 : After searching the technical support article in Macromedia web site and referring to the suggestions from other ColdFusion developer and programmer in the

ColdFusion Forum, it was suspected that the IIS was not mapping properly to the ColdFusion page. The problem was solved by reinstalling IIS, followed by ColdFusion. The IIS must be installed prior to the ColdFusion to map the servers correctly.

Problem 2 : SQL server requires username and password for the to create and utilize the database. However, ColdFusion failed to recognize the username and password to create a datasource which used to connect the database.

Solution 2 : By referring to the suggestion in the Internet resource, the problem was solved by reinstalling the SQL server.

Problem 3 : ColdFusion server manage the database through the ColdFusion Administrator under the ODBC datasource section. A datasource must be verified to establish the database connection. There were several times when the database connection was failed without any reason. The datasource verification failed after several attempts.

Solution 3 : The technical support of Macromedia was searched to seek for solution. However, there was no similar case that can be referred. Other resources showed no reference of the similar topic. The computer was then restarted to as

trial for database connection recovery. After several attempts, the connection was recovered.

8.1.2 Lack Of Knowledge in Web-based Development Environment

The EPAP developer has not had much experience in the Web-based development. As a result, the development process was confronting with some technical and other problems.

Problem : After putting all the EPAP's files into the root directory *wwwroot*, the ColdFusion page didn't change accordingly after changes were made in the coding. Clicking 'refresh' brought no effect to the page.

Solution : Without any knowledge of the reason of the problem, the Internet resource was searched to seek for solution of the same problem. It was discovered that it was due to the caching problem of the Internet Explorer. Temporary files were deleted to solve the problem.

8.1.3 Lack Of Knowledge in Web-based Scripting Languages

Another difficulty in the course of the development was the lack of knowledge in the Web-based scripting languages such as Javascript, DHTML and CSS. The programmer was restricted to deliver certain functions because it was difficult to translate into the unfamiliar Javascript syntax. The programmer chose the alternatives to

make the algorithm as easier as possible so that the syntax can be constructed using the limited syntax that the programmer was familiar with.

8.1.4 Lack Of Knowledge in User Interface Design Software

The programmer faced with difficulties using the Photoshop software because it was a new experience using such software. The numerous functions of the software were powerful to create fantastic image and user interface but require a lot of time for a beginner in master those skills. Unfortunately, the programmer had to complete the EPAP system in short timeframe. Simple and fundamental tutorials in the Internet were downloaded for a fast learning to design the user interface.

8.1.5 Time Limitation

Programmer had to follow a tight schedule because of the limitation of time. The EPAP must be completed in about 3 months. The lack of knowledge in various field had create pressures to the EPAP programmer. As problems occurred in the course the system development, the pace of the development was slowed down to figure the problem and to fix the problem. As such, the system was developed to fulfill the scope of the project without much expansion in the functions.

8.2 System Strengths

The EPAP system for the use of administrator and lecturers possess several strengths. The system strengths are listed as below.

i) **Advance security**

Login and logout process control the system user access. EPAP users have to register first using a confidential register key that will only be provided to the lecturer. This ensures that student will not register as lecturer. A registered user must go through another authentication process before he or she can gain access into the system. The EPAP administrator will authenticate the valid user. Only users with the status of 'authenticated' can log into the EPAP system. Besides, a user must login in order to use EPAP system. Simply type a file path in the location bar will not load the file. This is to prevent user to intrude into the system without login.

ii) **Auto-generated Exam ID**

A unique Exam ID is auto-generated when an examination paper is created. This automation ensures that Exam ID will not redundant as it will usually happen if the Exam ID is created manually by the lecturer. This eases lecturer work.

iii) **Create questions at one time**

The EPAP system allows the user to create an examination paper at one time. The system will automatically goes to the next question number when a question is created. The process will repeat until the final question.

iv) **Auto-calculation for total of marks**

The system will first capture the total marks of the examination. Then the marks will be deducted as the questions created with different marks. The user is informed about the remaining marks. This prevents the user from to have marks that exceed the total marks.

v) **Open for further modification**

The EPAP system is a flexible and dynamic which allow further modification on the examination paper which have just created. User can add more questions, edit the existing question and delete the question which no longer needed. Any modification will update the data in the database including the total marks of the examination.

vi) **Allow upload of image file**

The EPAP system also allow user to upload image file of size not exceeding 64K to enrich the content of the examination paper.

vii) **Organized printing**

The examination paper will be organized in manners that are ready to be printed out according to its question type. User may choose to print certain page, or print all pages at one time.

viii) **Organized display format of data**

All data or information is displayed accordingly in table or list form. The page number is enabled so the list of data is not lengthy in a page.

8.3 System Weaknesses and Limitations

The EPAP has its own limitations and weaknesses that need improvement. The limitations are discussed as below.

i) **Caching problems**

As the EPAP system process numerous data and many files are involved, the common draw back are the caching of the browser that display the earlier version of a file without updated data. Users have to reload the page by clicking 'refresh' for updated data.

ii) **Browser limitation**

Because the EPAP is developed with and for IE browser, there may be the possibility that EPAP will not function properly in other browser which does not support the Javascript.

iii) **Language Limitation**

The EPAP system is designed for examination in English or Malay only. Other languages may not be supported by the system and the database.

iv) **No validation of the file size of the upload file**

As the size of upload file cannot exceed 64K, any file exceeding 64K is uploaded will generate error in the system. There are currently no function of validation of the file size and prohibit user to upload above 64K. This function needs time for further study.

v) **No Font or Other formatting**

The font of the examination paper cannot be customized to other types. Other formatting such as underline, color and so-on are not provided in the EPAP system.

vii) **Fixed number of question in one page in printing**

The coding had fixed that there will be 3 questions in 1 page in MCQ examination paper, 2 questions in Structured and Essay.

8.4 Suggestions For Future Enhancement

There is still room for improvement in EPAP system. Suggestions for the future enhancement will try to overcome some of the system limitation stated above and try to add more features to the system. These suggestions are :-

i) **Validation of the upload file size**

This feature will validate the upload file size and prohibit user to upload file above 64K.

ii) **Allow user to customize the number of question in a page.**

User will be allowed to specify how may of question they want in a page. The system will then adjust to meet their needs.

iii) **A version of examination paper with answer.**

Currently, the EPAP is developed to create examination question paper. In the future, a version of 'answer paper' will be created for the use of a lecturer or teacher.

iv) **Examination created date and last modified date.**

These dates will help lecturer to schedule or organize their work better.

v) **Administrator notice or message to lecturer.**

This feature allow administrator to give notice or announcement or message to lecturer about the examinations or other issue so that the lecturer are well informed and keep up-to-date about what is happening around.

8.5 Conclusion

In conclusion, the EPAP project has achieved and fulfills the requirements and objectives as the web-based application system which eases the lecturer's or teacher's work to prepare for examination paper.

The literature review was a significant process where a lot of research and studies have been made to find out all the relevant information needed. The useful information has been translated into a solution after the analyst and could be used as future reference to develop similar system.

Throughout the EPAP system development, a lot of experience and knowledge such as setting up Client-Server technologies, programming concepts as well as the use of the software tools were gained. This experience is truly valuable. It will certainly help in future carrier in which various skills are required for more challenging task or solution.

Finally, EPAP system, is completed as a functional and dynamic application. Its strength has shown the potential and ability to become the teacher's or lecturer choice. Hopefully, future enhancement will make it an essential tool in the education industry.

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