

“BookBase e-Library System”

Final Report



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This dissertation is submitted in partial fulfillment of the
requirement of the Degree of MSc in Information Technology
of
the University of Moratuwa

Declaration

I certify that this dissertation does not incorporate, without acknowledgement, any material previously submitted for a degree and to the best of my knowledge and it does not contain any material previously published or written by another person or myself except where due reference is made in text. I also hereby give consent for my dissertation, if accepted, to be made available for photocopying and for interlibrary loans, and for the title and summary to be made available to outside organizations.

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Abstract

BookBase e-Library System will be implemented at Western College for Management & Technology (WCMT). WCMT is a campus facility with quality higher education programs affiliated to Bolton University UK and Edexcel UK, meeting international standards. The WCMT Campus was established in year 2011 in Mount Lavinia, Colombo with easy access to the students. WCMT is a BOI approved venture, and is a subsidiary of the KES Group of Institutions, which is a global education group, with significant experience in delivering transnational education across India, UAE, and now in Sri Lanka.

WCMT currently uses an obsolete in-house developed Library system and looking forward to replace the same. This existing system has been developed using a programming language called “Clipper”, which is no more supported by the latest operating systems such as Windows 7/8 or 2012 server.

WCMT current holds a book inventory of more than 5000 books across Management, Information Technology, Engineering, Languages, Law etc. With a student base over 1500, and a legacy Library system in operation, WCMT now faces many problems that affect their entire operations.



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Existing Library system at WCMT is an on premise single machine architected application with no separation of Database and the Application tiers. The data is stored as xxxx.dbf files and the program code is stored as xxxx.prg source file. These sources have been compiled to xxxx.exe files which could be executed on Windows platforms.

This obsolete architecture and the limitations of the technology used, greatly affect the applications suitability to the current business operations and the scalability required by the application.

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Chapter 1 – Introduction

1.1 Introduction

Pressman states that, “The process of building a product is sometimes called a lifecycle because it describes the life of that product from conception through to its implementation, delivery, use and maintenance”.

The Proposed BookBase e-Library System is a web based application attempts to automate small to medium type libraries across many industries such as Schools, Institutes, Universities and Organizations.

The System consists of an Admin panel and a User panel. Administrator is the highest privileged system user. Administrator is privileged to execute following functions:

- User management
- Grant/ Revoke privileges
- Profile
- DB admin
- Monitor logs
- Tune for performance
- Enforce security
- Backups / restore



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BookBase is a feature rich e-Library System which could entirely be operated through a web browser. Features are provided for following users:

Librarian

Library member

Staff member (if a school or university)

Following features will be available for the Librarian in the BookBase e-Library System

- Lend books
- Accept book returns
- Manage books
- Accept fines
- Book reservations
- Extension approvals
- Book sales
- Manage members

Following features will be available for the Library member / Staff member in the BookBase e-Library System

- Borrow books
- Return books
- Manage User Profile
- Pay fines
- Online reservations
- Online extensions
- Online membership
- Search book

System also has features to generate reminders for books that has exceeded the return due date. This will automate the current manual practices of the Librarian. The system can be linked to many e-book sites such as safari, google scholar etc. This also could be linked to academic and journal databases. Once a student reserves a book and whenever that book is available, the system automatically sends an email to the student who reserved the book. The student will have 2 days to borrow this book.

1.2 Background and motivation

BookBase e-Library System will be implemented at Western College for Management & Technology (WCMT). WCMT is a campus facility with quality higher education programs affiliated to Bolton University UK and Edexcel UK, meeting international standards. The WCMT Campus was established in year 2011 in Mount Lavinia, Colombo with easy access to the students. WCMT is a BOI approved venture, and is a subsidiary of the KES Group of Institutions, which is a global education group, with significant experience in delivering transnational education across India, UAE, and now in Sri Lanka.

According to the CEO of WCMT Campus, “The rapid recent growth of WCMT’s operations has added excessive pressure to the existing Library System and it has derailed the old obsolete system. The growth in the student base and the book/journal numbers together with the affiliations with foreign universities has added more burden to the operations of the Library. We soon want to embark on a new state-of-art library system that is localized to our operations”

WCMT currently users an obsolete in-house developed Library system and looking forward to replace the same. This existing system has been developed using a programing language

called “Clipper”, which is no more supported by the latest operating systems such as Windows 7/8 or 2012 server.

WCMT current holds a book inventory of more than 5000 books across Management, Information Technology, Engineering, Languages, Law etc. With a student base over 1500, and a legacy Library system in operation, WCMT now faces many problems that affect their entire operations.

1.3 Problem in Brief

Existing Library system at WCMT is an on premise single machine architected application with no separation of Database and the Application tiers. The data is stored as xxxx.dbf files and the program code is stored as xxxx.prg source file. These sources have been compiled to xxxx.exe files which could be executed on Windows platforms.

This obsolete architecture and the limitations of the technology used, greatly affect the applications suitability to the current business operations, and the scalability required by the application. A list of limitations/problems of the existing system is listed below:

- Limitations in advanced book search
- No grouping of copies of the same book editions
- No online interface for members to interact
 - o No online payments
 - o No online reservations
 - o No online book extension requests
- No integration to external e-book sites and other academic and journal databases
- No analytics available

1.4 Aim and Objectives

Aim:

The aim of this project is to develop a web based Library System to automate the library operations at WCMT University through the usage of state of art technology.

Objectives:

1. To eliminate the paper-work in library
2. To implement Barcode, SMS, Payment gateway technologies into the system
3. To design a user friendly graphical web based user interface which suit the users
4. To complete the system according to the project schedule
5. To develop the new system using the state-of-art technologies that enhances business value.

1.5 Structure of the report

In this report chapter 2 describes a literature review of current systems available for library system automation and related state-of-art technology trends used for building such systems. Chapter 3 explains the technologies that have been adapted to solve the problem. Chapter 4 depicts the proposed approach and the methodology to be used in designing and building the said system. Chapter 5 will include many diagrams explaining the analysis and design foundations of the system. Chapter 6 will have the details of implementation artifacts and finally a comprehensive discussion will be addressed in the last chapter, chapter 8.

Chapter 2 – Literature Review

2.1 Information Systems Development Methodologies

According to Maddison (1983), a software development methodology is ‘a recommended collection of philosophies, phases, procedures, rules, techniques, tools, documentation, management and training for developers of information systems’. It should be taken into consideration that sometimes a software development methodology is also called as an Information Systems Development.

In early days of software development industry, softwares were developed by using developers own methods. Most of the time the developers used forms of “code and fix” (n.d., 2003) which involved repetitive writing, testing and modifying of code and was a tedious cycle that did not guarantee the success of the applications. But with the improvement of this industry, organizations were focused to adapt more complex IT initiatives, resulting in the evolution of new methodologies.

Avison & Fitzgerald (2006) state that Information Systems Development Methodology is a “Collection of procedures, techniques, tools and documentation aids which will help the systems developers in their effort to implement a new information system. A Methodology will consist of phases, themselves consisting of sub phases, which will guide the systems developers in their choice of the techniques that might be appropriate at each of the project and also help them plan, manage, control and evaluate information systems projects”.

According to Moynihan (2000), “The notion of ‘requirements – uncertainty’ has received a lot of attention in the Information Systems (IS) and Software Engineering”.

This will be a major problem in the software development industry. Therefore solve this problem is very important since it influences,

- The ability of managers to plan and organize the development process
- The probability to proceed according to the plan
- The possibility of developing the product within the contractual constraints
- The success of the project (Sillitti et al (nd))

Since the Software development industry has the major problem in requirement uncertainty, it is very essential to select an appropriate methodology to determine the best methodology. Kamlesh and Ahmad (2008) points out that following factors such as:

“Organization’s size, the knowledge and experience of people working within the organization, hardware resources, application domain, and the corresponding software and system requirements” should be given a higher priority as success or failure of software development is highly depend on the methodology.

Different researchers have grouped information systems development methodologies based on different parameters. Among them widely used approach which is propose by Avison & Fitzgerald:

1. Process Oriented Methodologies

These methodologies are focused on identifying processes of the system and implementing them.

- i. Structured analysis, design and implementation of information systems (STRADIS)
- ii. Yourdon systems method (YSM)
- iii. Jackson systems development (JSD)

2. Blended Methodologies

These methodologies are not only focused on processes of the system but also data available within the scope.

- i. Structured systems analysis and design method (SSADM)
- ii. Merise
- iii. Information Engineering (IE)
- iv. Welti ERP Development (proposed by Norman Welti)

3. Object Oriented Methodologies

These methodologies are based on objects and classes concepts. They heavily support the reusability and these are the methodologies where CASE tools are most efficiently used nowadays.

- i. Rational unified process (RUP)

4. Rapid Development Methodologies

These methodologies are specially designed to achieve greater time savings during information systems development. Procedures, techniques and tools in these methodologies are specially focused to result in shorter development times.

- i. James Martin's RAD (most preferred and most popular)
- ii. Prototyping

5. People-oriented Methodologies

These methodologies rely on the expertise and knowledge of people who are available for development process. Therefore other than technical considerations these methodologies have special tools and techniques to capture human knowledge and expertise.

- i. Effective technical and human implementation of computer-based systems. (ETHICS is sometimes considered as an organizational-oriented methodology)
- ii. Knowledge Acquisition and Documentation structure (KADS)
- iii. Common KADS

6. Organizational-oriented Methodology

These methodologies do not focus only on developing an information system alone. They consider overall information systems strategy of an organization when developing an information system for it. Even though there are draw backs too, these methodologies usually result in products that fit to the scenario.

- i. Soft System Methodology (SSM is one of the most preferred)
- ii. Information Systems work and analysis of change (ISAC)
- iii. Process Innovation (PI)
- iv. Projects in controlled environments (PRINCE)

7. Agile Methodologies

These methodologies are specially designed to cater Agility in software development projects. There are no strict rules and regulations governing these methodologies. There are only guidelines and an individual can follow the guidelines whatever the way that person perceives them. Some of the currently available agile methodologies are originally agile while some others are modified to cope with agility that is present in almost all ongoing software development projects.



Many people consider agile methodologies to be an extension of RAD. But significant differences can be observed between these two groups of methodologies since RAD does not support free thinking to the extent Agile does and agile has a more flexible approach towards identifying user requirements. Therefore the scope of the agile methodologies in this research consists of following 8 topics.

- i. Extreme Programming (XP)
- ii. SCRUM
- iii. Feature Driven Development (FDD)
- iv. Dynamic Systems Development Method (DSDM)
- v. Adaptive Software Development (ASD)
- vi. Agile Method

2.2 Evaluation of Methodologies

2.2.1 Waterfall Methodology

“Waterfall is an approach to development that emphasizes completing a phase of the development before proceeding to the next phase (Sorensen(1995)). In this approach development is done by the step by step. If a requirement is identified to change, a formal changing process has to be followed since each phase is well documented.

Waterfall method is suited for situations where the requirements and the implementation of those requirements are very well understood. In this approach tight control is maintained throughout the life cycle. According to the problem stated in above ‘requirements – uncertainty’, users are unable to provide the requirements at the initial stage of the methodology. And also this methodology use of extensive written documentation, as well as formal reviews and approval/ signoff by the user and the development team at the end of each phases before beginning the next phase. (nd (2008))

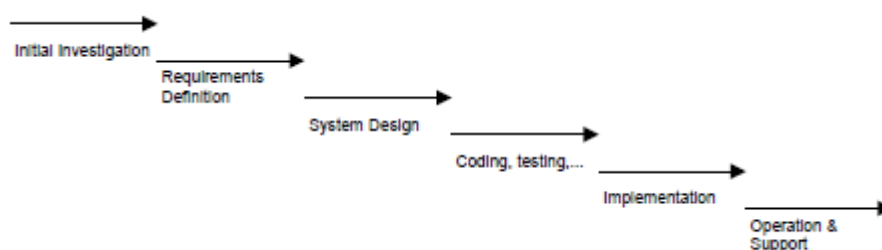


Figure 1 - Waterfall Methodology

Source: nd (2008)

Most appropriate situations	Least appropriate situations
Project is for development of a mainframe-based or transaction-oriented batch system	Large projects where the requirements are not well understood or are changing for any reasons such as external changes, changing expectations, budget changes or rapidly changing technology
Project is large, expensive and complicated	The continual evolution of the project requirements; the need for experienced, flexible team members drawn from multiple disciplines; and the inability to make assumptions regarding the users' knowledge level.
Project has clear objectives and solution	Real-time systems
Pressure does not exist for immediate implementation	Event-driven systems
Project requirements are stable or unchanging during the system development life cycle	Leading-edge applications
Developers has fully knowledge about the business application	
Team members and project manager may be inexperienced	
Strict requirement exists for formal approvals at designated milestones	

Source: nd (2008)

Table 1: Comparison of waterfall Methodology

Considering the above facts waterfall methodology is not suitable for 'requirements – uncertainty' environment projects.

2.2.2 Rational Unified Process

Ambler (2005), states that, 'The IBM Rational Unified Process (RUP) is a prescriptive, well defined system development process, often used to develop systems based on object and or component based technologies'.

“It is based on sound software engineering principles such as taking an iterative, requirements- driven, and architecture- centric approach to software development.”
 (Kruchten 2004 cited Ambler 2005).

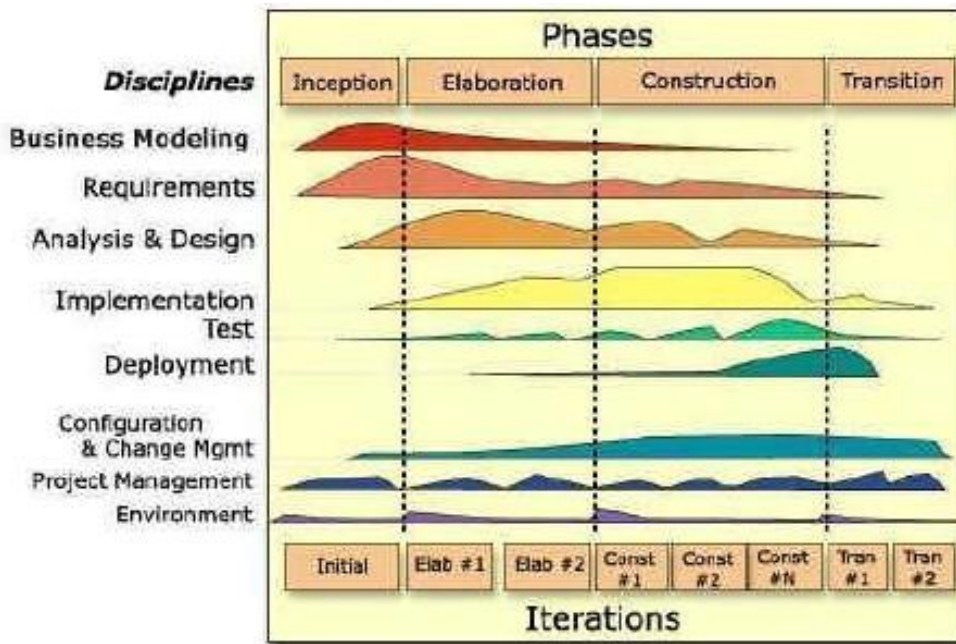


Figure 2 - Rational Unified Process
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 Source: Ambler (2005).
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According to Ambler (2005), RUP projects spend approximately 10% of time in Inception, 25% in Elaboration, 55% in construction and 10% in Transition. Therefore in RUP methodology, not concern about the requirement uncertainty life time of the methodology.

RUP work in Practice

A normal procedure is to address some subset of the requirements, carry out some analysis, go back and re work some of the requirements, move to design, re- work some requirements, start on coding. Likewise requirements can continually add to the system, after implementing the system also. RUP is working as iterations. These are planned according to risks. Higher priority risks are addressed in earlier iterations while lower priority risks are addressed later.

Importance of RUP

The RUP's iterative and incremental approach has several advantages over other methodologies.

1. Improved Governance

The delivery of high quality software which meets the actual requirements of the customers

2. Regular feedback to stakeholders

Users can see the end product while developing

3. Improved Risk Management

Working as phases support higher risks to be addressed early

4. Implement the actual requirements

Requirements are uncertainty; therefore expecting to define requirements at the beginning is unrealistic. By developing systems in smaller iterations can build actual needs which meet the actual needs of the stakeholders.

5. Developers focus on what matters

In RUP methodology developers more focus on construction phase. Since that is the phase users can actually see the product. (Ambler (2005))



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2.2.3 Agile Methodology

Software development methodology has moving from traditional methodologies to modern software development methodologies. According to Erharuyi (2007), “The new approach to software development was developed by agile alliance, whose motivation was based on the complexity and ever increasing excess documentation involve in software development process.” Instead of defining a methodology they agreed upon 4 values and 12 principles that are to be honored in agile development. Their values were

1. Individuals and interactions over processes and tools
2. Working software over comprehensive documentation
3. Customer collaboration over contract negotiation
4. Responding to change over following a plan”

Haynes (2006) states, “Agile software development is an approach to building systems that emphasizes evolutionary development, customer centricity, and low documentation/specification overhead”.

Most of the development company’s move in to agile methodology because;

- Agile methods are adaptive rather than predictive
- Agile methods are people oriented rather than process oriented

In agile methodology there are many flavors, as stated above. Out of that Extreme Programming is further discussed to evaluate applicability of requirement uncertainty problem.

Extreme Programming (XP)

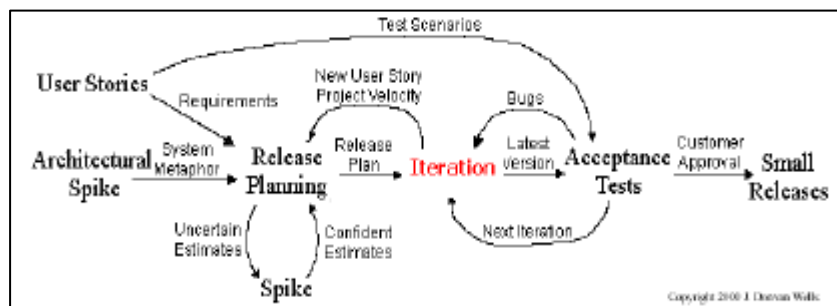
This is an incremental model that puts the client in the driver seat and this is the most popular of agile family. Clients will able to get the clear picture about the project. The final product will not be developed at once. Therefore clients have to selects the features that will be included in the next build. The major advantage of this approach for small to medium size systems is that it works when the user’s requirements are continually change. This methodology is very flexible to user point of view compare to the other methodologies.



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According to Erharuyi (2007), Extreme Programming “as a discipline of software development based values of simplicity, communication, feedback and courage”.

The philosophy of extreme programming says “let software development be fun, flexible, predictable, less risky, efficient and more scientific”. (Beck 2000 cited Erharuyi (2007))



Source: Erharuyi (2007)

Figure 3 - Extreme Programming

Following table discussed about the core values of XP

Value	Description
Simplicity	“Programmers actually code what is needed in the current work; they don’t bother themselves to code designs that are meant to take care of future requirements”. (Aderson 1998 cited Erharuyi 2007). Therefore requirements are uncertainty since clients cannot predict all requirements at once.
Communications	Compare to other methodologies XP has very good communication within project team and client. This enables to adapt scope, quality, resources and time.
Feedback	Feedback helps to identify customer needs and also helps to know if customer needs have been met, if not corrected.
Courage	“ Developers need courage to face a real life situation” (Erharuyi 2007)

Table 2: Values of Extreme Programming

Based on the values of the Extreme Programming (Beck 2000 cited Erharuyi 2007) created the principles such as Rapid feedback, assume simplicity, making incremental changes, enhance change and do quality work. Those criteria’s are help to increase the values of this methodology.

Strengths and Weaknesses of the XP

eXtreme Programming is an adaptive and people oriented methodology, very flexible which allows software development to keep pace with rapid changing business needs. This methodology provides response to requirement uncertainty problem.

Advantages	Disadvantages
Quick prototype delivery	Not scalable
Iterative approach to development	Too much emphasis on early results delivery
Rapid respond to changing requirements needs	Test drive approach extends development time
Create room for experimental designs	Unstructured approach to development
Enhanced system reliability	Lack of predictability therefore lack of planning

Refactoring enhances software quality	Not suitable for large size team
Higher rate of code production	
Collective code ownership	
Access to dedicated users	
Lower overhead	
Suitable for medium size team	
Allows flexibility	

Source: (Erharuyi 2007)

Table 3: Advantages and Disadvantages

Application of XP methodology in Industry

As a result of uncertainty of user requirements increases, most of the project managers move to iteration delivery methods rather than stick in to traditional waterfall life cycle model.

Number of researches conducted on the applicability of eXtreme Programming suggests that it is widely used in the current software development industry.



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A study by Sillitti et al (nd) proves that 75% of the agile companies and 63% of the document driven companies, requirements vary “often” or “always”. Furthermore 88% of the document driven companies and 13% of the agile companies consider the requirements variability the most difficult problem to deal with during requirement gathering process.

According to Haynes (2006), “ Integration of customer representatives into the system development team is crucial to provide direct links to the source of system requirements as well as to ensure that accountability is correctly apportioned between the user group responsible for identifying, clarifying and prioritizing system requirements and the system development team responsible for realizing these requirements in working systems. “

Survey carried out by Rumpe & Schroder (2001), states that “Interest in the XP approach is constantly increasing worldwide throughout all software intensive application domains”. And also 100% of the asked developers would reuse XP in the next project, when appropriate.

Avison & Fitzgerald (2006) discussed “A number of organizations are utilizing XP in their software development to reap its potential efficiency gains.” In this approach customer defines their requirements in user stories; by using these stories developers should identify the requirements of the proposed systems.

Apart from above discussion of eXtreme Programming changed in the way it does business discussed by Reifer (nd), “Emphasis on agility and time to market, many software shops have made the move to extreme programming/ agile methods. Those methods focus on building working products instead of the documents and formal reviews that are frequently used to demonstrate progress in more classical developments. These releases, which are working versions of the product, not prototypes, are used to demonstrate functions and features to stakeholders”.



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2.3 Literature Review - Library Systems Available in the Industry

Many world class library systems are available in the industry. Many organizations have deployed such systems and have automated their respective business operations. An off-the-shelf product is quick to deploy when compared to a custom solution, and gives you access to a user community. Upgrades are generally provided at a reduced cost, and assuming you select a quality product, you'll enjoy strong customer support. Best yet, if it's a web based product, you won't have the hassle of installing any hardware or software.

Although an off-the-shelf product can be implemented quickly and backed by customer support, it does have a few potentially major shortcomings. Off-the-shelf products are designed to satisfy the basic needs of many different companies across a variety of industries. That means the unique needs of a particular business might not be met. It also means that an organization may be paying for (and frustrated by) features that the business doesn't need. Additionally, an off-the-shelf product may work for the business today, but it can't be easily modified and isn't designed to accommodate future needs.



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Some of these systems are detailed below:

LIBERO:

LIBERO has continued to provide library software that supports the needs of hundreds of libraries worldwide. Developed in collaboration with librarians, the LIBERO product range has evolved with industry needs to include customisable discovery, consortia and mobile friendly solutions that are available, fully-integrated with the core LIBERO LMS (library management system). Built from the ground-up to be entirely accessible through a web browser.



Alice:

Windows based library management solution targeted for schools market. Alice is an easy to use, reliable and effective library management system where you may not have access to the latest technology or IT infrastructure. Alice has been evolved for the last twenty years and is still popular with librarians that are not looking for a web based solution. Alice has not included new features in recent years and still on an obsolete desktop platform.



Library Management System:



Library Management Software has been designed to automate, manage and look after the over-all processing of very large-scale libraries. This software is capable of managing Book Issues, Returns, generating various Reports for Record-Keeping and Review purposes. The system can be configured for many types of Institutions, public and digital libraries for managing their circulation and stocks. Librarians and media specialists have contributed ideas to make this software flexible and user friendly.

Koha:



Koha is a full featured open-source Integrated Library System (ILS). There is no cost for the license, a client has the freedom to modify the product to adapt the needs, etc. Developed initially in New Zealand by Katipo Communications with Horowhenua Library Trust. It is currently maintained by a dedicated team of software providers and library technology staff from around the globe. Today more than 300 libraries are using Koha, including academic, public, school and special libraries, in Africa, Australia, Canada, USA, France, India and, of course, New Zealand. Along with a committed team of programmers its development is steered by a growing community of librarians collaborating to achieve their technology.

2.4 Drawbacks of off-the-shelf (pre-built) Library Systems

Even though the above Library Systems are pre-developed and are deployed at various Libraries around the world, they inherit various disadvantages. Bob Mango discusses many of these in his article “To Build or To Buy: Comparing Custom and Off-The-Shelf Software Applications”

One of the main drawbacks of such systems, particular related to the local context is the **Total Cost of Ownership** (TCO) they carry. Organizations today usually take a five year TCO to assess the investment. TCO consists of many components such as the License Fee of the Application, License Fee of the Middleware, License Fee of the Database C). Together most of the above systems carry a significant cost over a period of, Implementation Fee, Customization Fee and Annual Maintenance Cost (AM five year life span. Open source systems such as Koha will carry a heavy

Implementation, Customization and an AMC fee component even though the License fee is not applicable.

Another drawback of such internationally based systems is the ***Local Support and Service***. Many of these library systems do not have a local representation hence, the support and service will be provided through an agent of another country. Many drawbacks such as Cost of Service, Time difference and the SLA (Service Level Agreements) will play a major role in such situations. Many of these international vendors will find it difficult to service a local client in long term perspective as the local market does not have many opportunities for similar systems and the interest of this foreign software vendor will soon diminish.

Many of these systems were designed in a manner that they ***lack integration to existing legacy systems***. If the organization consists of many existing systems, the integration might become complex and time consuming.

Customization to local market, and the features/functionality required by WCMT cannot be provided by most of these pre-build generic software solutions. This inflexibility is a major drawback to improve operations of WCMT. This inflexibility might also trigger a high customization cost in the WCMT demand the customizations.

2.5 Drawbacks of Customized Software builds

The latest CHAOS results show a scariest picture of increasing failure of customized software projects. The failure rate rates has increased to a rocketing 70% of all projects being not delivered on time, on budget, and with required features and functions.

In 1986, Alfred Spector, president of Transarc Corporation, co-authored a paper comparing bridge building to software development. The premise: Bridges are normally built on-time, on budget, and do not fall down. On the other hand, software never comes in on-time or on-budget. In addition, it always breaks down. One of the biggest reasons bridges come in on-time, on-budget and do not fall down is because of the extreme detail of design. The design is frozen and the contractor has little flexibility in changing the specifications. However, in today's fast moving business environment, a frozen software design does not accommodate

changes in the business practices. Therefore a more flexible model must be used. This could be and has been used as a rationale for development failure.

But there is another difference between software failures and bridge failures, beside 3,000 years of experience. When a bridge falls down, it is investigated and a report is written on the cause of the failure. This is not so in the computer industry where failures are covered up, ignored, and/or rationalized. As a result, we keep making the same mistakes over and over again.

The Standish Group research shows a staggering 24% of projects will be cancelled before they ever get completed. Further results indicate 52.7% of projects will cost 189% of their original estimates. The cost of these failures and overruns are just the tip of the proverbial iceberg. The lost opportunity costs are not measurable, but could easily be in the trillions of dollars. One just has to look to the City of Denver to realize the extent of this problem. The failure to produce reliable software to handle baggage at the new Denver airport is costing the city \$1.1 million per day.

2.6 Future of Customized Software builds



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Agile based methodologies have evolved into the most efficient, flexible software development methodologies which are industrially accepted. Almost all kind of projects and size of companies can leverage on agile based methodologies with a minimal effort on process tailoring. This would mean more cost effective systems that deliver the requirements raised by users and stakeholders. The software would be shelf ready quicker with less rework compared to the other software developed using other methodology prevalent.

Choosing the correct development methodology will determine the success of the software product being developed. Agile allows the team to gather requirements without impeding previous requirements understanding. This allows the team to scope the software in the correct way and produce the desired outcome.

The Standish Group research shows that companies which were migrated from Planned based (waterfall) methodologies to empirical based (Agile) methodologies have improved the success rate of Software development/implementations. Further, Standish Group highlights that over the next 5 years, the improvements will continue further.

Chapter 3 - Technology adapted

3.1 XAMPP

The main technology adapted to the success of the project is the blend of PHP, Apache and MySQL to form the solution. This comes as XAMPP and

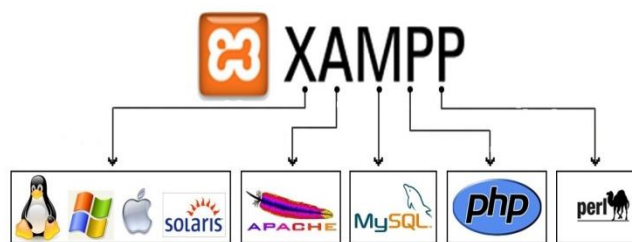


Figure 4 - XAMPP abbreviation

very popular in the industry to build similar scale solutions. XAMPP is a free

and open source cross-platform web server solution stack package, consisting mainly of the Apache HTTP Server, MySQL database, and interpreters for scripts written in the PHP and Perl programming languages. XAMPP is the most popular PHP development environment and is completely free. The XAMPP open source package has been set up to be incredibly easy to install and to use. XAMPP has been around for more than 10 years – there is a huge community behind it. The goal of XAMPP is to build an easy to install distribution for developers to get into the world of Apache. To make it convenient for developers, XAMPP is configured with all features turned on. There are currently distributions for Windows, Linux, and OS X.

In general, XAMPP is used for web development on the local machine, as opposed to directly on the web space. It allows tinkering and testing out changes on the personal computer before making those changes publicly online. The XAMPP package is simply an easy way to install all the vital web server parts all at once, though it's just as possible to install them all individually and by hand instead.

3.2 Model View Controller (MVC)

MVC is the software architecture used for implementing user interfaces. It divides a given software application into three interconnected parts, so as to separate internal representations of information from the ways that information is presented to or accepted from the user.

The MVC design pattern assigns objects in an application one of three roles: model, view, or

controller. The pattern defines not only the roles objects play in the application, it defines the way

objects communicate with each other. Each of the three types of objects is separated from the others by abstract boundaries and communicates with objects of the other types across those boundaries. The collection of objects of a certain MVC type in an application is sometimes referred to as a layer, for example, model layer.

Model is the objects within the application. It's the Object Oriented Approach and Design which encapsulates the data in the DB. This is the brains of the application logic, business rules and application data.

View is the presentation layer that is seen and interacts by the user. The View component comprise of web pagers - HTML, CSS, Java Scripts. This will used for different types of displays, colours, layouts etc.

Controller is going to process and respond to events such as user actions and invoke changes to the model and the view based on that. It's going to make decisions for us and controls what happens. Controller handles the communications between users and the Model.

3.2.1 Basic Web Architecture

In basic web architecture, we have a Browser that interacts with a Web page. A web server hosts this web page. Web page might have lots of code that make decisions and outputs something back to the web browser. Web page might even interact with a Database, pull data and return back to the Browser.

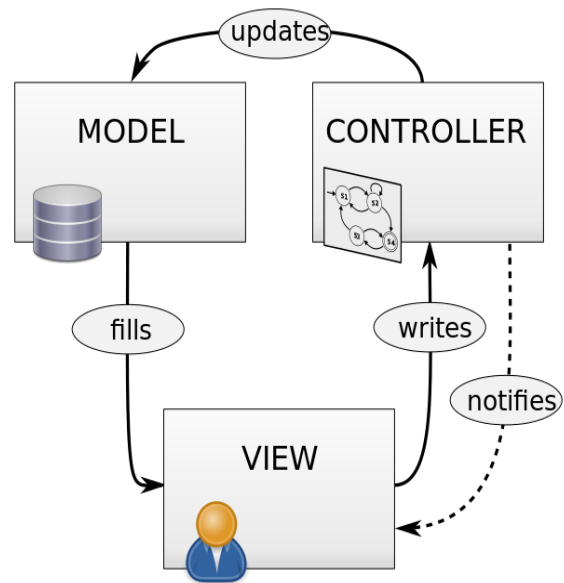


Figure 5 - MVC Architecture



Figure 6 - Basic Web Architecture

3.2.2 MVC Architecture

MVC architecture attempts to break this single web page in to many different components. Instead of having this one web page with all code muddled-up and with diverse business logics which take different actions based on user interactions, MVC architecture breaks it up. A Browser will communicate to the Controller. The Controller will only contain the code to invoke those decisions that should get executed base on the actions.

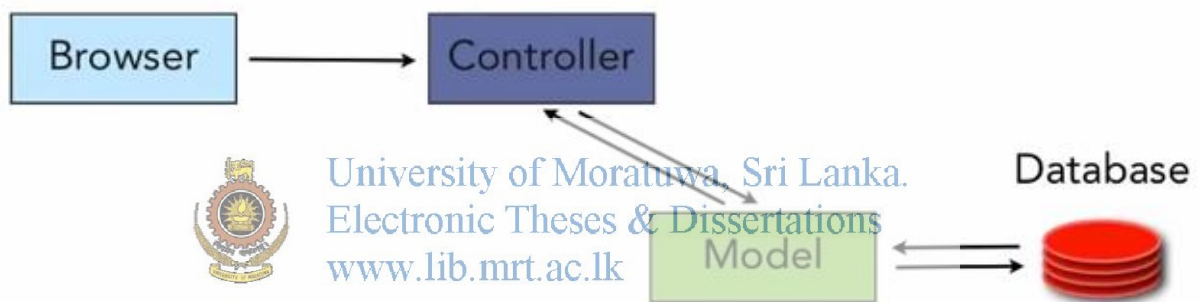


Figure 7 - MVC Overview

When needed to interact with the Database, the Controller communicates with the Model. The Model will have all the code relating to and connecting with the Database. Model can return its results back to the Controller. Controller can go back to the Model if required and Model and go back to the Database if required.

Finally when the Controller is satisfied that it's ready to return a result to the Browser, the Controller will send the results to the View, the presentation layer, which will decide what HTML, JavaScript's, CSS would get returned back to the Browser.

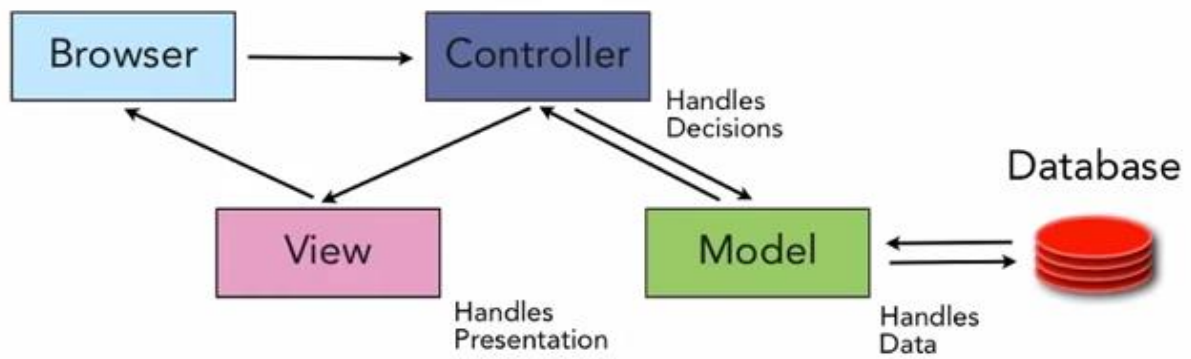


Figure 8 - MVC Breakdown

Essentially the one Web page is now broken down based on the functionality to Controller, Model and the View. The Controller handles the decisions, the Model handles the data and View handles the presentation.

3.3 NetBeans

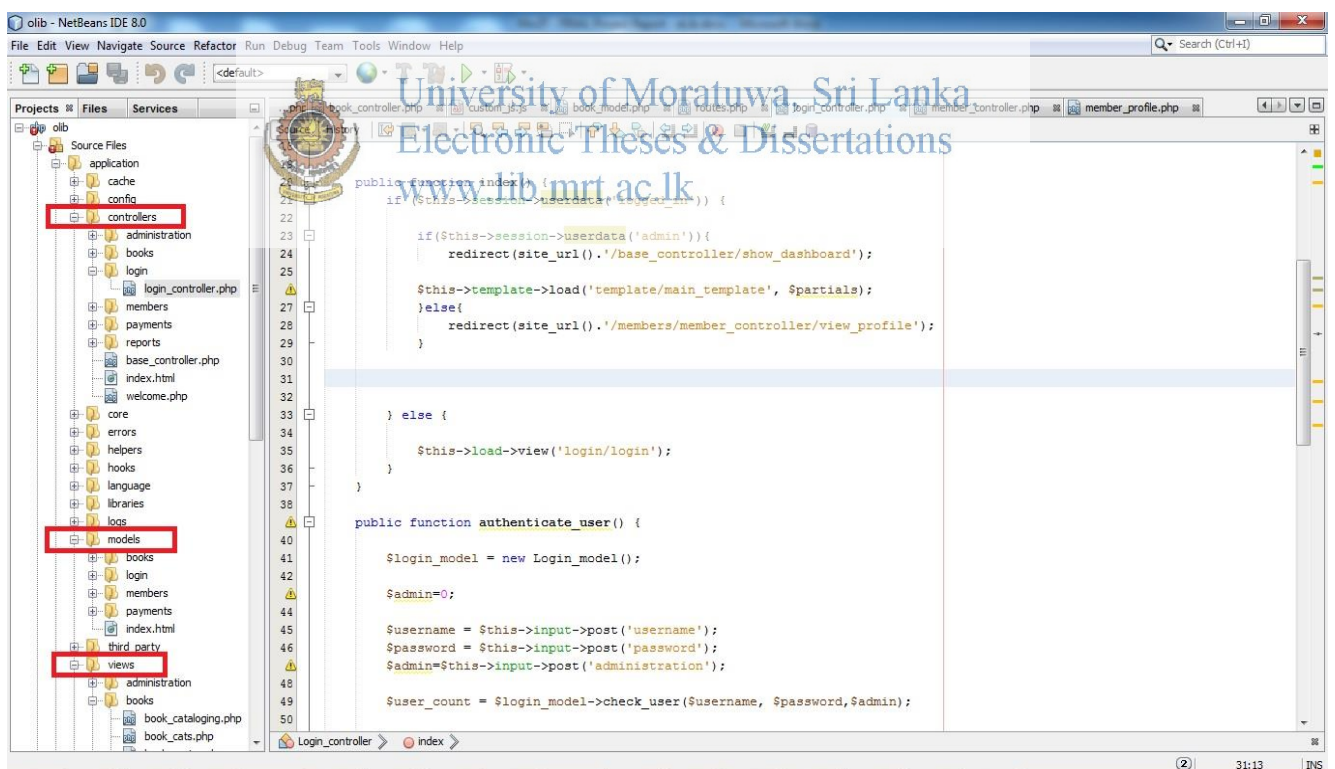


Figure 9 - NetBeans IDE

NetBeans IDE 8.0 has been used for the entire development of the system. The NetBeans Platform is a generic framework supported for multiple languages, cross platform applications and desktop/browser based applications. It provides the "plumbing" that, before,

every developer had to write themselves—saving state, connecting actions to menu items, toolbar items and keyboard shortcuts; window management, and so on.

The NetBeans Platform provides all of these out of the box. Many basic features need not manually code anymore. The platform does not add a lot of overhead to your application - but it can save a huge amount of time and work.

The NetBeans Platform provides reliable and flexible application architecture. Application does not have to look anything like an IDE. It can save years of development time. The NetBeans Platform gives a time-tested architecture for free. An architecture that encourages sustainable development practices. Because the NetBeans Platform architecture is modular, it's easy to create applications that are robust and extensible.

As depicted above, the folder structure for MVC (Model, View & Controller) has been maintained in the Online Library project. Many classes are indicated within the folder view.

3.4 CodeIgniter

CodeIgniter is an Application Development Framework - a toolkit - for people who build web sites using PHP. Its goal is to enable you to develop projects much faster than you could if you were writing code from scratch, by providing a rich set of libraries for commonly needed tasks, as well as a simple interface and logical structure to access these libraries. CodeIgniter lets you creatively focus on your project by minimizing the amount of code needed for a given task. CodeIgniter builds structured code using OOP concepts.

CodeIgniter is loosely coupled based on the popular Model-View-Controller development pattern. While view and controller classes are a necessary part of development under CodeIgniter, models are optional. CodeIgniter is most often noted for its speed when compared to other PHP frameworks.

3.5 The Benefits of the Technology adapted

The entire spectrum of technology adapted is Open Source technology and tools. These are the most commonly used tools and technology in today's commercial application development.

XAMPP is a completely free, easy to install Apache distribution containing MySQL, PHP, and Perl. The XAMPP open source package has been set up to be incredibly easy to install

and to use. This bundled nature of Web Server (Apache), Database Server (MySQL) and Programming frameworks (PHP & Pearl) makes it less complex. The central administration of these bundle components again adds many benefits to a programmer/administrator and even to an organization.

Main objective of the MVC model is to create separation of concerns, in other words separation of user interface with the business logic. The benefit of this separation is that any component can be amended without affecting the other component. i.e change to the user interface (View) can be done without touching the business logic (Model) and vice versa. Code reusability is another benefit of MVC.

CodeIgniter builds structured code using OOP with a small footprint. Which provides exceptional performance with in the entire application. CodeIgniter is not based on large-scale monolithic libraries. Which make it easy to manage and maintain. The solution generated is simple and not complex.



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Chapter 4 - Proposed Approach

Based on the findings highlighted in Literature Review section, I decided to select Agile based approach as Agile approaches have face less failures according to Standish Chaos Report. Out of many approaches in Agile, Scrum is prominent and used by most software organizations.

4.1 Scrum Approach

Scrum is a way for teams to work together to develop a product. Product development, using Scrum, occurs in small pieces, with each piece building upon previously created pieces. Building products one small piece at a time encourages creativity and enables teams to respond to feedback and change, to build exactly and only what is needed.

More specifically, Scrum is a simple framework for effective team collaboration on complex projects. Scrum provides a small set of rules that create just enough structure for teams to be able to focus their innovation on solving what might otherwise be an insurmountable challenge.



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However, Scrum is much more than a simple framework. Scrum supports our need to be human at work: to belong, to learn, to do, to create and be creative, to grow, to improve, and to interact with other people. In other words, Scrum leverages the innate traits and characteristics in people to allow them to do great things together.

4.2 How does Scrum work?

Building complex products for customers is an inherently difficult task. Scrum provides structure to allow teams to deal with that difficulty. However, the fundamental process is incredibly simple, and at its core is governed by 3 primary roles.

Product Owners determine what needs to be built in the next 30 days or less.

Development Teams build what is needed in 30 days (or less), and then demonstrate what they have built. Based on this demonstration, the Product Owner determines what to build next.

Scrum Masters ensure this process happens as smoothly as possible, and continually help improve the process, the team and the product being created.

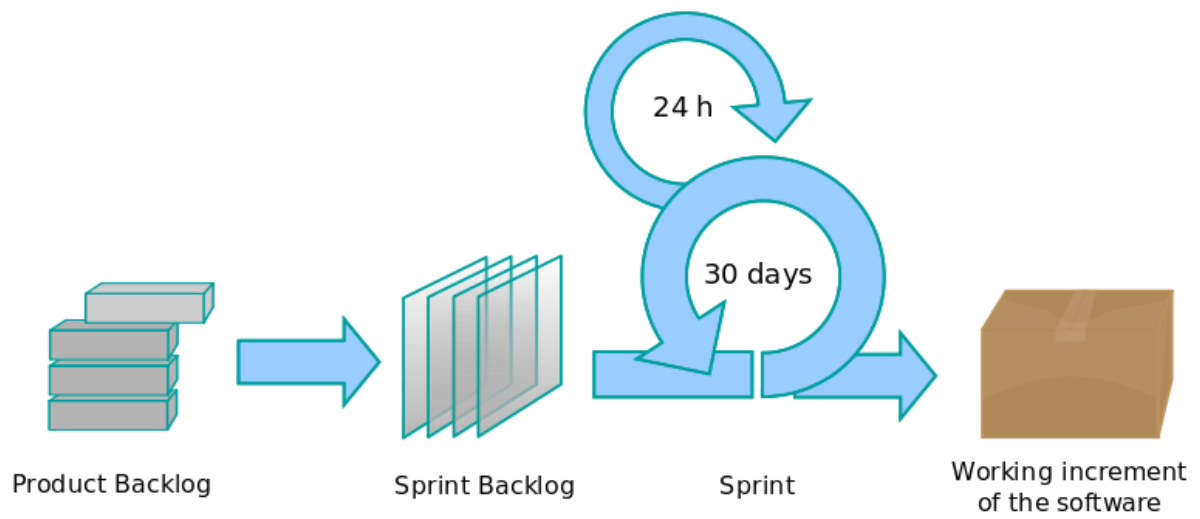


Figure 10 - Scrum Methodology



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Chapter 5 - Analysis and Design

5.1 Introduction

Scope and Purpose

The purpose of this Design is to present the system design at a level that can be directly traced to the specific system objective along with providing more detailed data, functional, and behavioral requirements. This Design Document will verify that the current design meets all of the explicit requirements contained in the system model as well as the implicit requirements desired by the customer.

Overall System Design Objectives

The overall system design objective is to provide an efficient, modular design that will reduce the system's complexity, facilitate change, and result in an easy implementation. This will be accomplished by designing a strongly cohesion system with minimal coupling. In addition, this document will provide interface design models that are consistent, user friendly, and will provide straightforward transitions through the various system functions.



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Project Design Constraints

The BookBase e-Library system must be able to handle current and up-and-coming technology. The internet must be able to communicate with a browser client in HTML and PHP. The server must be on a Windows 2012 server, or higher. The client must run on Windows XP and higher.

5.2 Modular View

The BookBase e-Library System consists of many modules focused on doing different aspects of library operations. A high-level overview of each module is presented below:

 <p style="text-align: center;">Acquisitions</p> <p>The functionality required to efficiently manage the order, purchase and receipt of catalogue resources.</p>	 <p style="text-align: center;">Cataloguing</p> <p>Management of the way the library collection is presented to the members</p>	 <p style="text-align: center;">Circulation</p> <p>Functionality required to efficiently manage the circulation of the library resources</p>
 <p style="text-align: center;">Messaging</p> <p>Engine for alerts and notifications via emails and SMS's.</p>	 <p style="text-align: center;">WebConnect</p> <p>Easy-to-use integration options such as web services, XML etc.</p>	 <p style="text-align: center;">Mobility</p> <p>Smartphone friendly interface to connect with mobile users.</p>
 <p style="text-align: center;">Reporting</p> <p>Many standard reports and customizable templates cover all system modules</p>	 <p style="text-align: center;">Admin</p> <p>Entire technical aspects of the eLibrary system will be handled by the Admin. Operations such as Backups / Restorations, Tuning, User privileges etc will be handled by the Admin</p>	 <p style="text-align: center;">OPAC - Search</p> <p>eLibrary system can easily search book author, Title, Publication using an inter-operable gateway – OPEC (online public access catalog)</p>

Figure 11 - Modular View of the System

5.3 System Architecture Design

System Architecture

The BookBase e-Library System is a client-server based system, which contains the following layers: user interface, internet/LAN communication, functional service, and data storage layers.

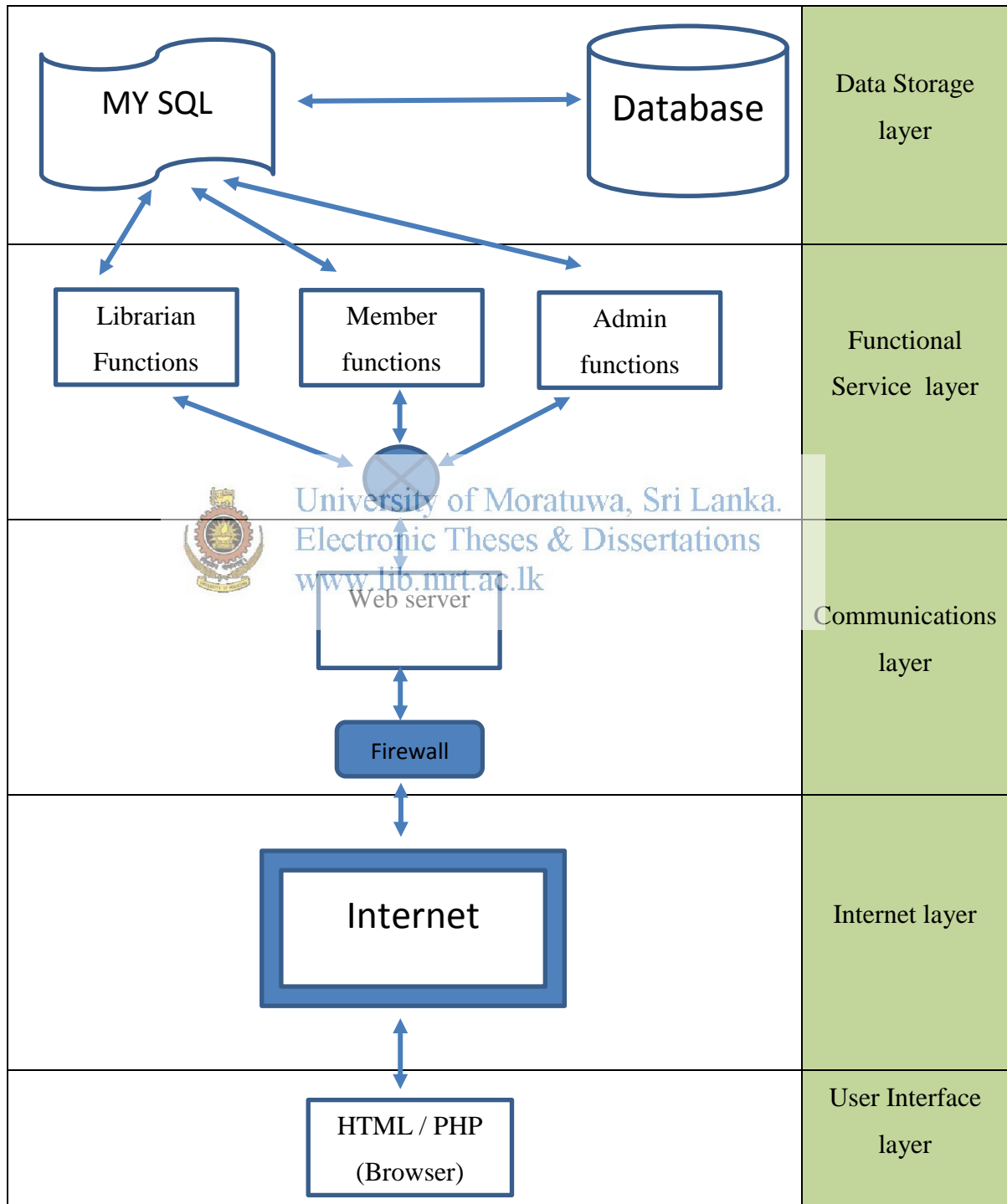


Figure 12 - System Architecture

Server Architecture

In a real environment, the server architecture contains two logical servers. The first of which, the web server, will interface with users using PHP and HTML as shown in the communication interface block within the following diagram. The second logical server, the Database server, will be the central repository of all data for the application.

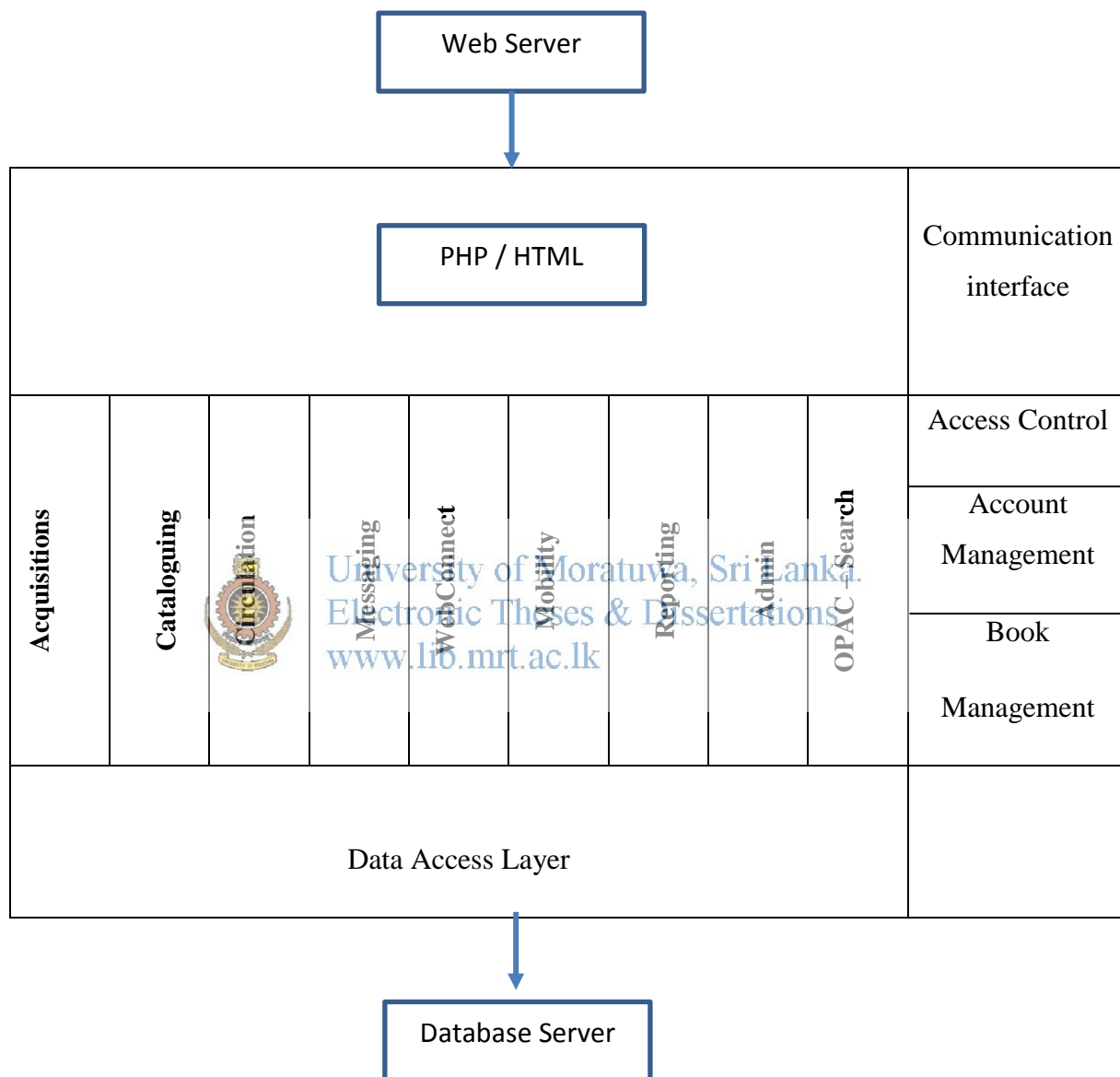


Figure 13 - Server Architecture

5.4 Data Flow – Context Diagram (DFD)

A data flow diagram (DFD) is a graphical representation of the "flow" of data through an information system, modeling its process aspects. Often they are a preliminary step used to create an overview of the system which can later be elaborated. DFDs can also be used for the visualization of data processing (structured design).

A DFD shows what kind of information will be input to and output from the system, where the data will come from and go to, and where the data will be stored. It does not show information about the timing of processes, or information about whether processes will operate in sequence or in parallel.

A context diagram is a top level data flow diagram. It contains one process node that generalizes the function of the entire system in relationship to external entities. Context diagram shows the interaction between the system and external agents which act as data sources and data sinks.



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This context-level DFD is next "exploded", to produce a Level 1 DFD that shows some of the detail of the system being modeled. The Level 1 DFD shows how the system is divided into sub-systems (processes), each of which deals with one or more of the data flows to or from an external agent, and which together provide all of the functionality of the system as a whole. It also identifies internal data stores that must be present in order for the system to do its job, and shows the flow of data between the various parts of the system.

Below is the context DFD for BookBase e-Library System. The entire system is represented with a single process. The external entities interacting with this system are members, librarian, non-members, finance department and administrator.

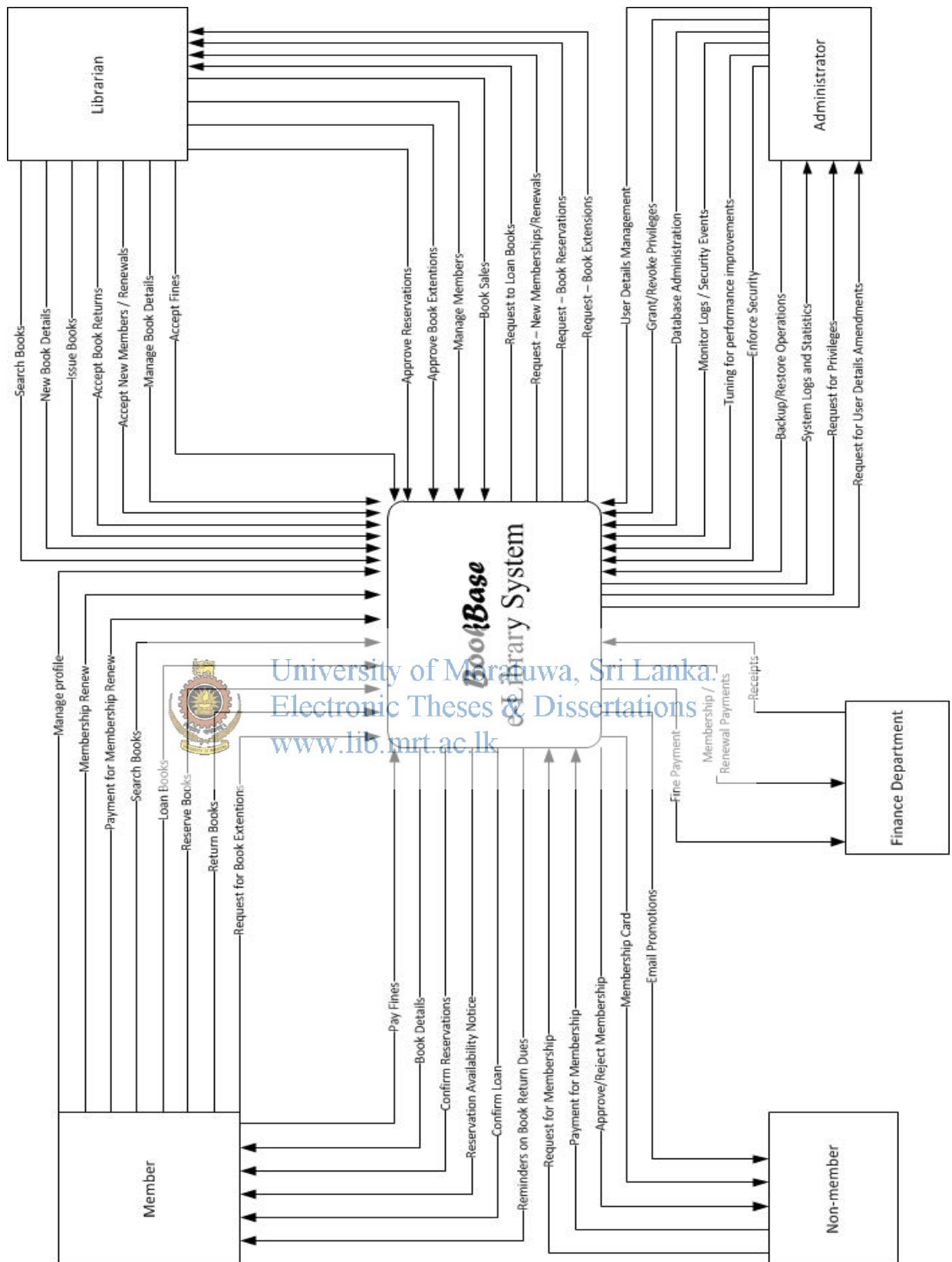


Figure 14 - DFD Context Diagram

5.5 High Level Entity Relation Diagram (ERD)

An ER diagram of a library database management system helps to keep all aspects of running a library organized. The diagram should include the books and publishers, as well as members of the library and who has checked out which books.

The ER data modeling techniques is based on the perception of a real world that consists of a set of basic objects called entities, and of relationships among these objects. In ER modeling, data is described as entities, relationships, and attributes.

One of the basic components of ER model is entity. An entity is any distinguishable object about which information is stored. These objects can be person, place, thing, event or a concept. Entities contain descriptive information. Each entity is distinct. An entity may be physical or abstract. A person, a book, car, house, employee etc. are all physical entities whereas a company, job, or a university course, are abstract entities.

After identifying an entity, then we describe it in real terms, or through its attributes. Attributes are basically properties of entity. We can use attributes for identifying and expressing entities. For example, Dept entity can have DeptName, DeptId, and DeptManager as its attributes. A car entity can have modelno, brandname, and color as its attributes.

A particular instance of an attribute is a value. For example, "Bhaskar" is one value of the attribute Name. Employee number 8005 uniquely identifies an employee in a company. The value of one or more attributes can uniquely identify an entity.

The below preliminary ER diagram is just an indicative representation of the entire entity and its relationship base of the eLibrary System. This ERD will further enhance and improved during the next stages of the project. The Cardinality refinement, Resolution of many-to-many relationships, introducing other related entities and their relationships will be made available in the final report of the project.

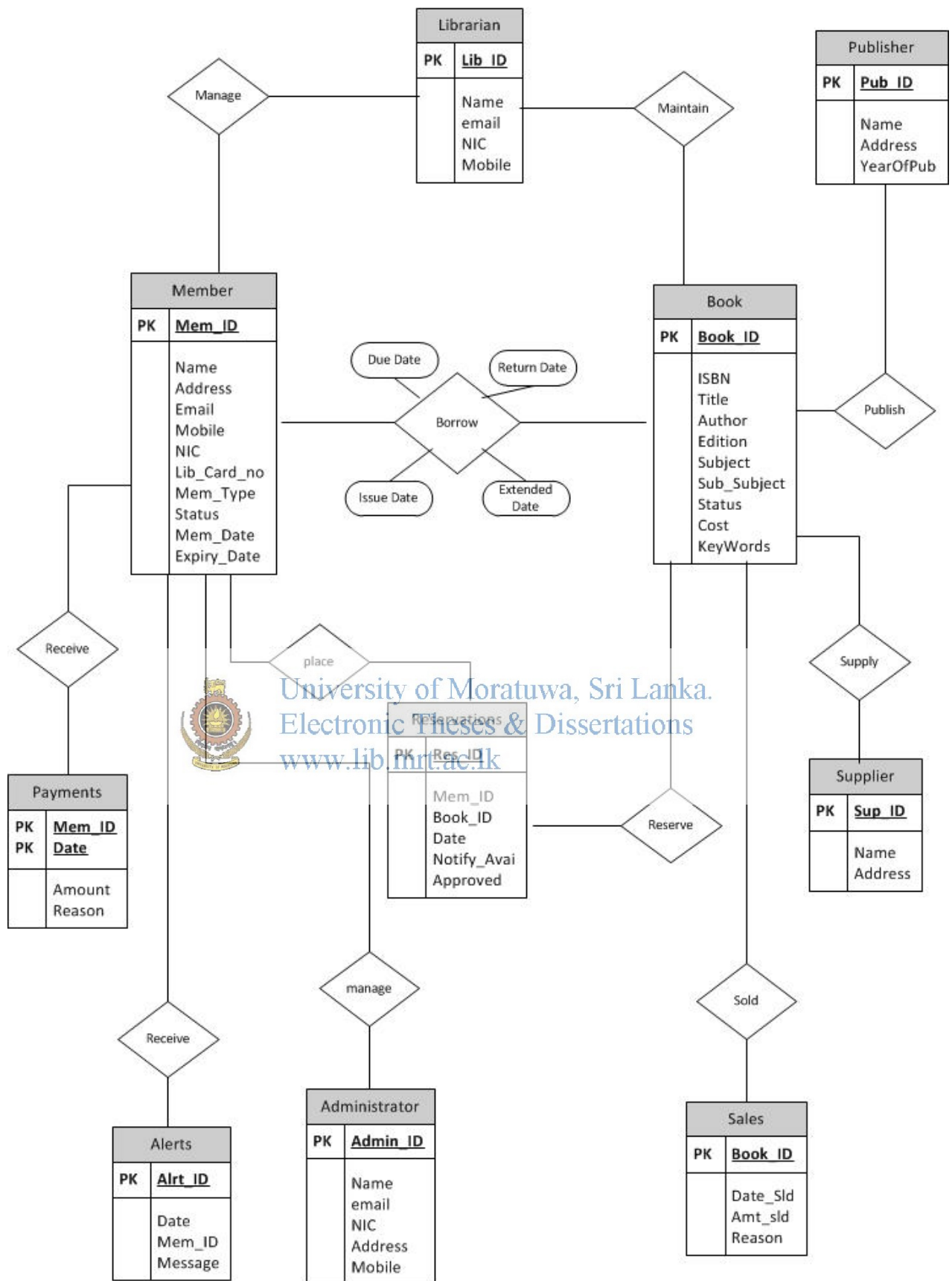


Figure 15 - High Level Entity Relation Diagram (ERD)

5.6 Data Objects

Provide below is a summary of the various data objects that make up the BookBase e-Library system. Included in each table are the attributes of each object, the data type for each attribute, the number of characters allowed for each field, the default value, and any other information that defines the field (i.e., calculation for overdue fees).

MEMBER Object			
attributes	data type	length	Constraint
Mem_ID	String	10	PK
Name	String	40	
Address	String	40	
Email	String	25	
Mobile	String	10	
NIC	String	10	
Lib_card_no	String	10	
Mem_type	String	5	
Status	String	1	
Mem_date	Date	8	
Expiry_date	Date	8	

BOOK Object			
attributes	data type	length	Constraint
Book_ID	String	10	PK
ISBN	String	20	
Title	String	40	
Author	String	40	
Edition	String	10	
Subject	String	20	
Sub_subject	String	20	
Status	String	1	
Cost	Decimal	15	
Keywords	String	100	

LIBRARIAN Object			
attributes	data type	length	Constraint
Lib_ID	String	20	PK
Name	String	40	
email	String	40	
NIC	String	10	
Mobile	String	20	

PUBLISHER Object			
attributes	data type	length	Constraint
Pub_ID	String	10	PK
name	String	40	
Address	String	40	
YearofPub	String	4	

RESERVATIONS Object			
attributes	data type	length	Constraint
Res_ID	String	10	PK
Mem_ID	String	10	FK
Date	Date	8	
Notify_Avai	String	40	
Approved	String	1	

PAYMENTS Object			
attributes	data type	length	Constraint
Mem_ID	String	10	PK, FK
Date	Date	8	
Amount	Decimal	10	
Reason	String	40	

SUPPLIER Object			
attributes	data type	length	Constraint
Sup_ID	String	10	PK
Name	String	30	
Address	String	40	

ALERTS Object			
attributes	data type	length	Constraint
Alrt_ID	String	40	PK
Date	Date	8	
Mem_ID	String	10	FK
Message	String	40	

ADMINISTRATOR Object			
attributes	data type	length	Constraint
Admin_ID	String	10	PK
Name	String	30	
Email	String	30	
NIC	String	10	
Address	String	40	
Mobile	String	10	

SALES Object			
attributes	data type	length	Constraint
Book_ID	String	10	PK, FK
Date_Sld	Date	8	
Amt_Sld	Decimal	10	
Reason	String	40	

5.7 Functional Partitioning

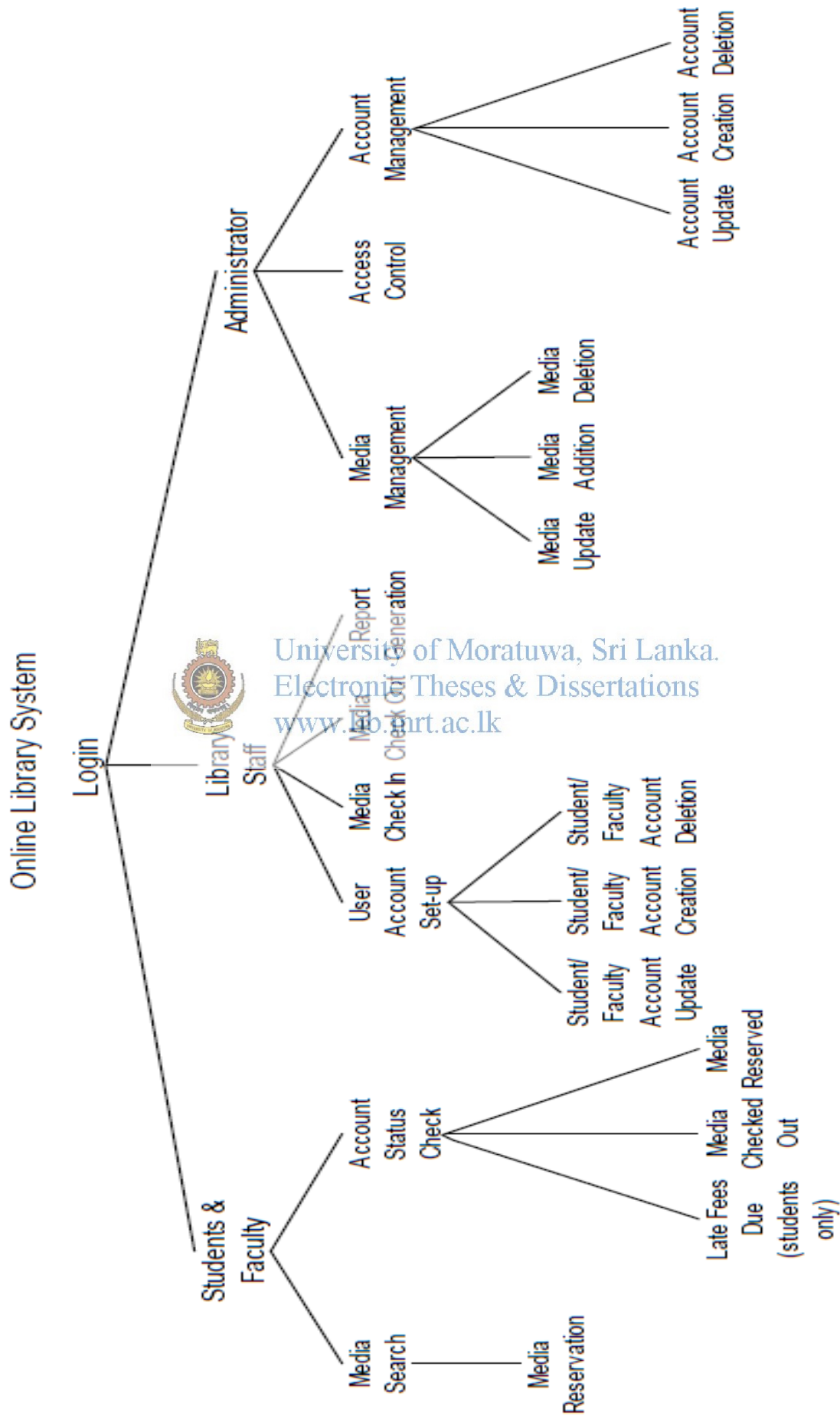


Figure 16 - Functional Partitioning

5.8 Functional Description

Function 1: Login Function (Shared Function)

This function is both for security and to control the user's level of access. This function requires the user's ID, and Password. The user type is managed by the access control function. The system will verify that the user ID and Password are all correct before allowing access to the BookBase e-Library system. If the information is not correct, the user will receive an error message requesting that the user try again. With a correct login, the user will be taken to the appropriate menu. The student and faculty users will be able to login from any machine using an internet browser or from within the library using the LAN connection. The library staff will login via the library's LAN. The administrator will be able to login via the LAN connection or, for data management operations, the administrator will be able to logon to the actual server. Access time for account validation and determination of user access is expected to be no more than one second via the LAN connection and no more than five seconds using a remote internet browser.

Function 2: Media Search Function (Shared Function)

The media search function will search the media database for books, magazines/periodicals, and multi-media. The user can search for a book by title, author, subject, or ISBN. Magazines and periodicals can be searched by publication and issue date only. A separate system is already in place for specific article searches and will not be linked to the main BookBase e-Library system. Multi-media searches can be performed either by title or subject. This function will return and display all items that match the query criteria. Access time for this function is expected to be no more than three seconds via the LAN connection and no more than ten seconds using a remote internet browser.

Function 3: Media Reservation Function (Student/Faculty Function)

The media reservation function allows the user to reserve media resources that are currently checked out. When the user performs a search, the availability information for the resource will also be displayed. The screen will display the resource status, the expected availability date, and if the book is already on reserve for another student or faculty member. The user will have the option to reserve the resource by selecting the reserve resource field. The student will automatically be notified by email when the

resource is available. Only books and multi-media will be accessible for reservation. Magazines and periodicals can only be viewed in the library and are not available for check out. A student will not be allowed to have for than five resources on reserve at one time. An error message will be displayed if the user tries to exceed this limit. Access time for this function is expected to be no more than three seconds via the LAN connection and no more than ten seconds using a remote internet browser.

Function 4: Account Status Check Function (Student/Faculty Function)

The account status check will allow users to check the status of their library account. When this function is selected it will provide the following three options: view all resources currently checked out by the user, all resources on reserve, and a check for overdue fee. If the user selects resources borrowed, the title of each resource and the respective due date will be displayed. The resources reserved option will provide each title reserved by the user including the expected availability date. Only student accounts will include an overdue fee check; overdue fees will not be assessed for faculty. If the student selects this option, there will be an option to pay overdue fees online with a credit card (see overdue fee payment function). Access time for this function is expected to be no more than three seconds via the LAN connection and no more than ten seconds using a remote internet browser. Times may also be slower for credit card payments as the credit card must be verified through the banking system.

Function 5: Overdue Fee Payment Function (Student Function)

Students will be able to pay any overdue fees that may have been assessed using the overdue fee payment function. The user's balance will be displayed when this function is selected along with a button labeled Pay Fees. The user will be prompted for a credit number, expiration date, and the name on the card. The user will then submit the request, which will be processed using an online banking system. The bank will verify the user's information and return verification of the transaction once it has been approved. An error message will be displayed if the payment cannot be processed. The account balance field will be updated immediately. The time for this function will vary depending on the volume of transactions being processed through the online banking system, but the maximum transaction time is not expected to exceed 10 seconds.

Function 6: User Account Set-up Function (Library Staff and Administrator Function)

Both library staff members and the system administrator will have access to this function, although most student and faculty accounts will be set up by the library staff. There are three subfunctions: account update, account creation, and account deletion. The menu will display these three options and the staff member will make the appropriate selection. The screen will display fields for the user's ID, Password, user type, address, email address, and phone number. The user will be given a default Password and then prompted by the system for a new Password on the first login.

Function 7: Media Check in/Check out Functions (Library Staff Function)

The checkin/checkout functions will be performed by the library staff. All resources are identified in the database by a unique index number. This number will be entered to select the media resource. When checking out a resource, the availability status will change, the student/faculty member ID number will be assigned to the resource, and a due date assigned. There is a limit to the number of resources that can be checked out to a single user at any given time.



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Function 8: Report Generation Function (Library Staff and Administrator Function)

Both the library staff and administrator will be able to generate a variety of pre-defined status reports as well as customized reports. The report function will include a complete resource status report, a listing of all user accounts, and a list of all overdue fees owed. Reports may also be generated using any combination of the search fields. The time required to generate reports is expected to be no more than ten seconds via the LAN connection.

Function 9: Media Management Function (Administrator Function)

Managing the media will include adding new resources to the database, updating resources already in the database, and deleting resources. When adding a new resource to the database, the system will automatically assign it a unique index number. This number will be used for the checkin/checkout function to identify the media resource.

Function 10: Access Control Function (Administrator Function)

The administrator will control the level of access for each type of user. Upon user login, the user type will identify the level of access and trigger the appropriate menu display. The user account validation will also be managed through this function. If the user name, user ID, and Password IN cannot be verified by the system, the user will be returned to the login screen and an error message will be displayed. If the user inputs an incorrect password on more than three consecutive attempts, the access control function will disable the account. Reinstatement of the account will require the assistance of a library staff member or the administrator. The administrator will have direct access to the database server and will perform most media management functions while logged onto this server. This will result in immediate response times.

Function 11: Account Management Function (Administrator Function)

All user accounts will be managed by the administrator. Although the library staff may set up student/faculty accounts, only the administrator may set up library staff accounts and other administrator accounts. There are three subfunctions: account update, account creation, and account deletion. The menu will display these three options and the administrator will make the appropriate selection. The screen will display fields for the library staff member's ID, Password, user type, extension, position, and email address. The staff member will be given a default Password and then prompted by the system for a new PIN on the first login.

NOTE

Due to the time constraint and limited resources, not all the above functionality has been implemented in the final system. But above will definitely be a consideration for future application enhancement.

Chapter 6 - Implementation

6.1 Introduction

Systems implementation is the construction of the new system and the delivery of that system into production (that is, the day-to-day business or organization operation).

The construction phase does two things: builds and tests a functional system that fulfills business or organizational design requirements, and implements the interface between the new system and the existing production system. The project team must construct the database, application programs, user and system interfaces, and networks. Some of these elements may already exist in your project or be subject to enhancement.

To implement a system successfully, a large number of inter-related tasks need to be carried out in an appropriate sequence. Utilizing a well-proven implementation methodology and enlisting professional advice can help but often it is the number of tasks, poor planning and inadequate resourcing that causes problems with an implementation project, rather than any of the tasks being particularly difficult. Similarly with the cultural issues it is often the lack of adequate consultation and two-way communication that inhibits achievement of the desired results.

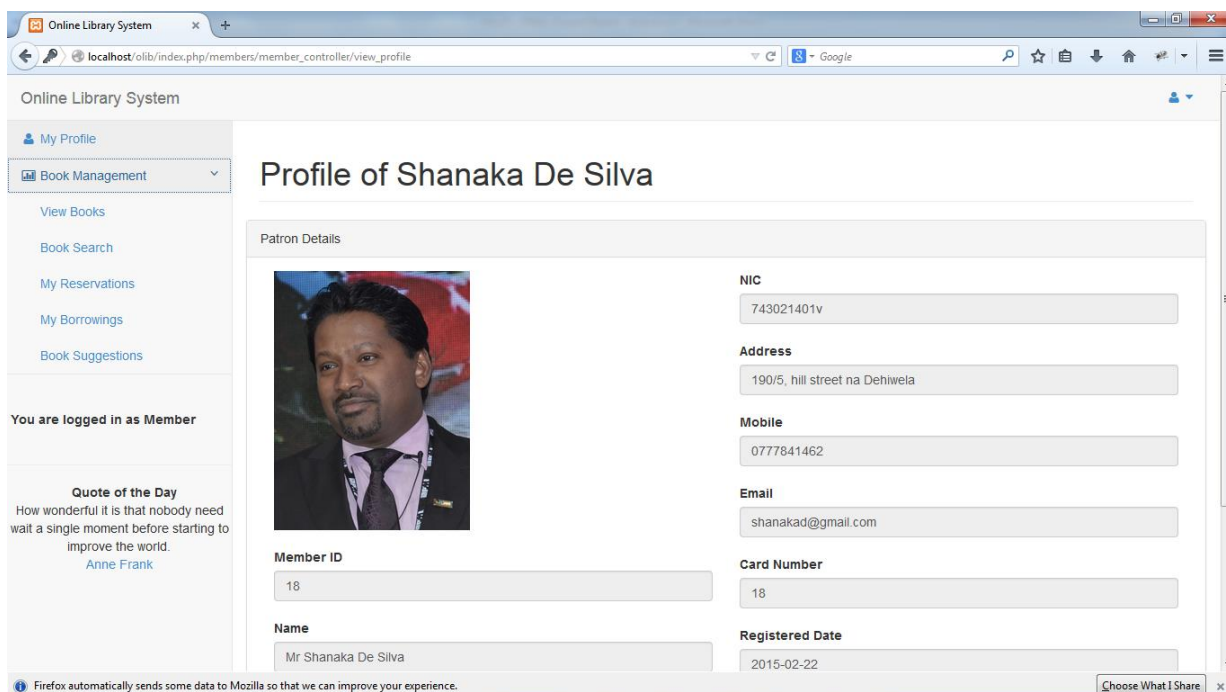
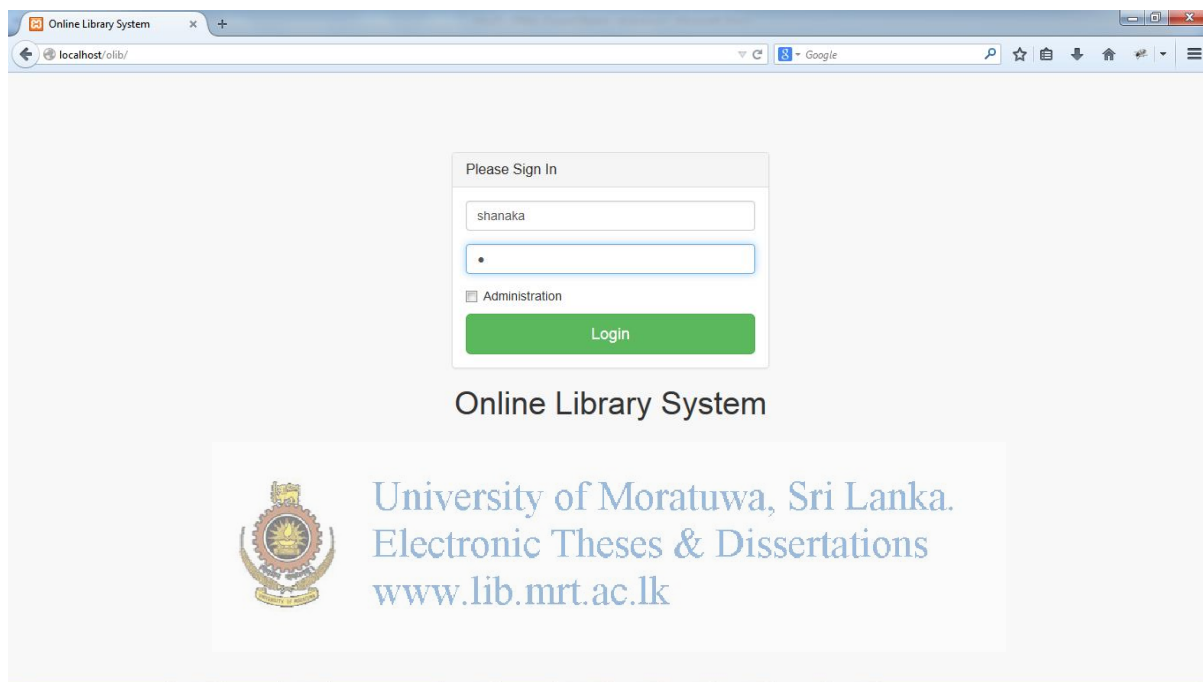
System implementation generally benefits from high levels of user involvement and management support. User participation in the design and operation of information systems has several positive results. First, if users are heavily involved in systems design, they move opportunities to mold the system according to their priorities and business requirements, and more opportunities to control the outcome. Second, they are more likely to react positively to the change process. Incorporating user knowledge and expertise leads to better solutions.

The relationship between users and information systems specialists has traditionally been a problem area for information systems implementation efforts. Users and information systems specialists tend to have different backgrounds, interests, and priorities. This is referred to as the user-designer communications gap. These differences lead to divergent organizational loyalties, approaches to problem solving, and vocabularies.

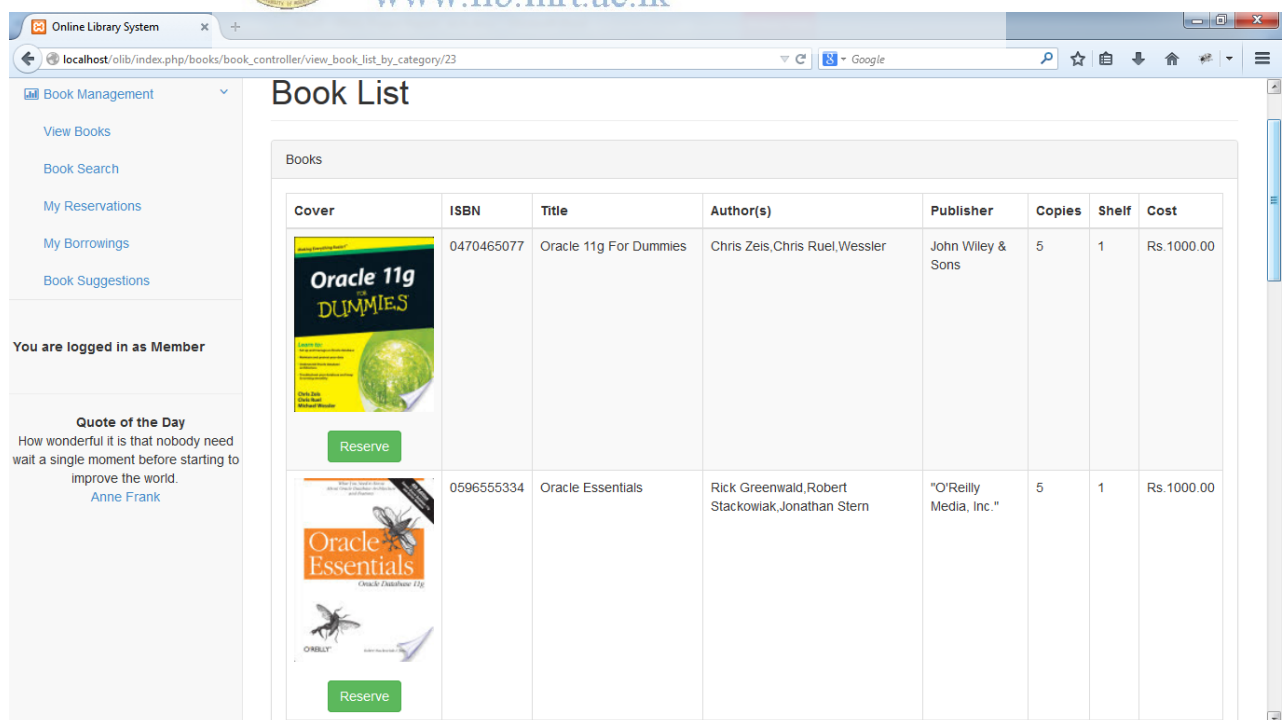
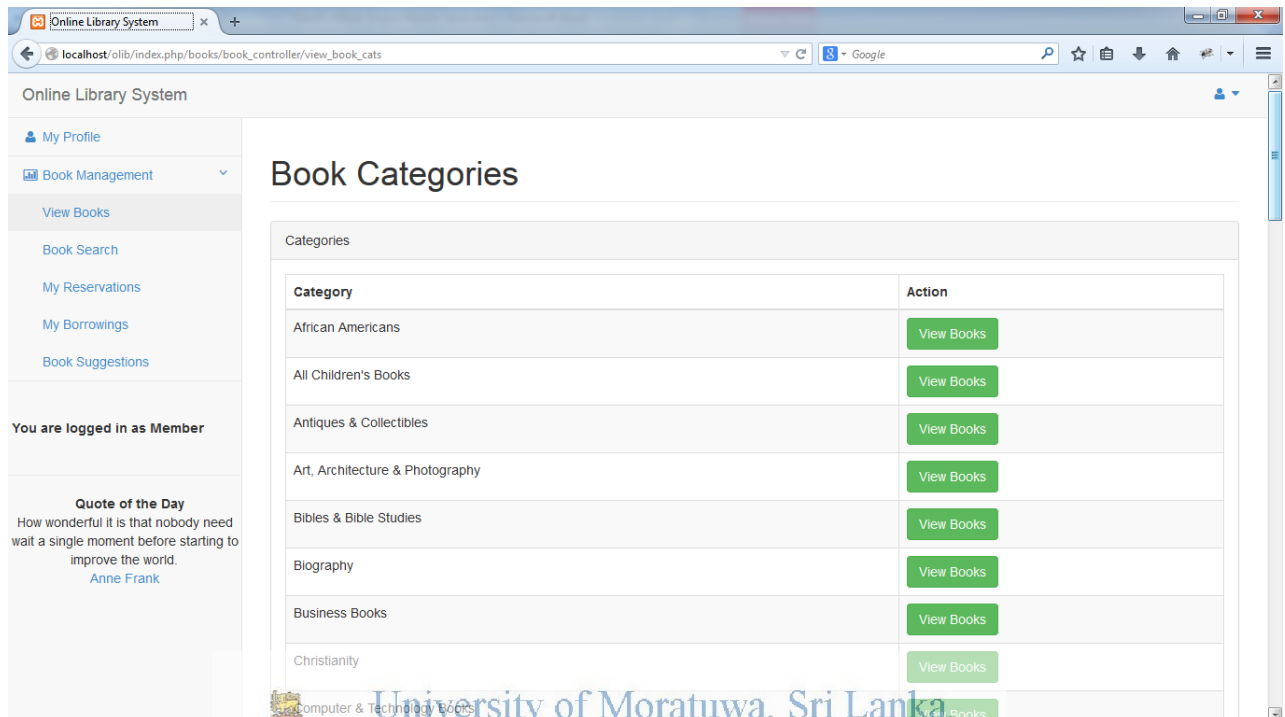
6.2 Interface Design

Library member

When a Library member connects to the online library system, the initial login web page will be displayed. Once the user id and the password entered, clicking of Login button will take the member to his/her profile page. The same login screen will be used by the Librarian and the Administrator as well.

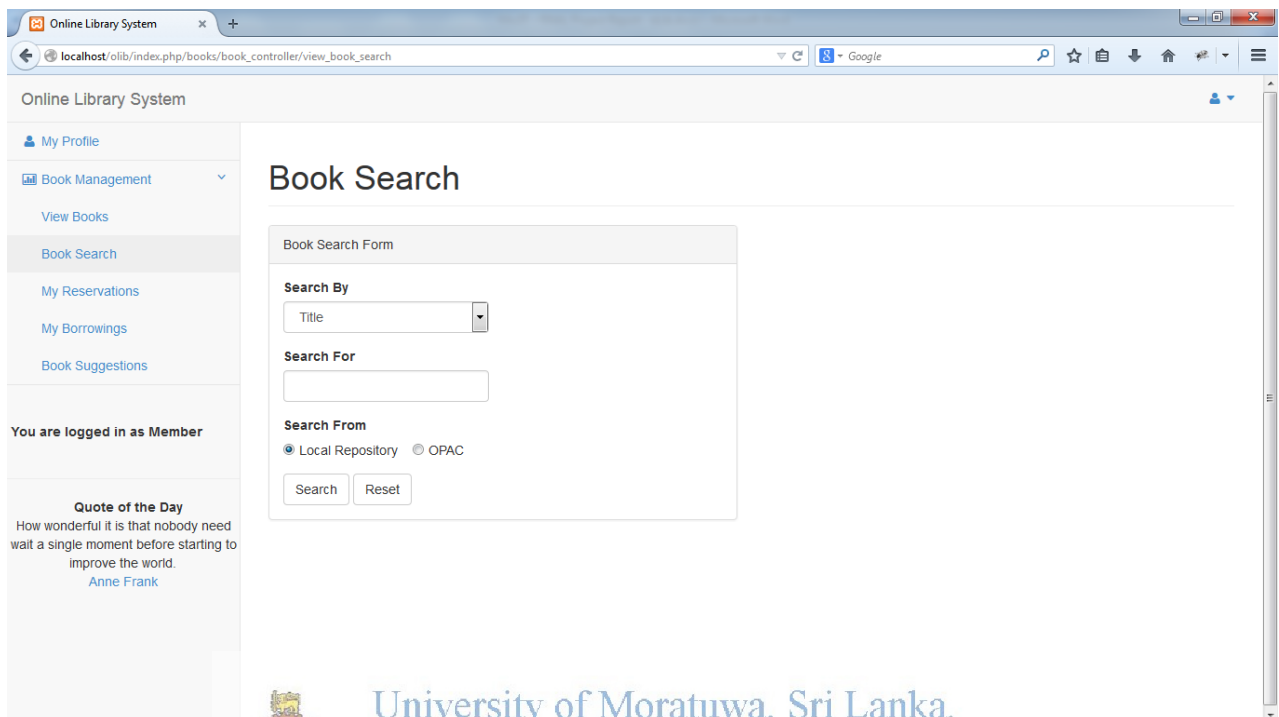


“View Books” menu option can be used by a Library Member to browse through book categories and once a category is selected by pressing “View Books” button; all the books under that category will be listed.



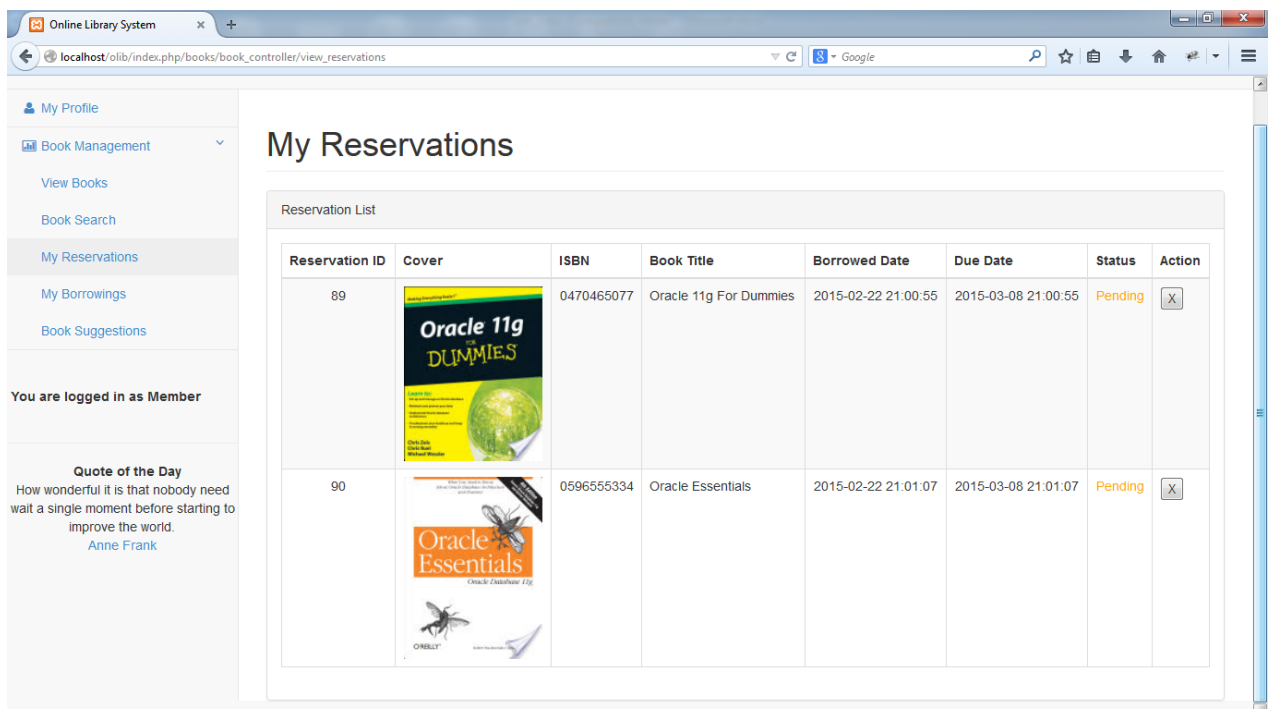
Library Member can reserve a book by pressing the “Reserve” button at the bottom at each book. A member can reserve up to a maximum of 3 books.

To search a book, “Book Search” menu option can be used. Multiple search criteria are available to the Library Member such as search using Title, ISBN or Author. Search can be made to the local library books or to internet book sites via OPAC (online public access catalog).



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To view all the pending reservations, Library Member can use the “My Reservation” menu option. Member has the option to cancel the reservations by clicking the “X” button in the action column.



To view all the books borrowed, Library Member can use the “My Borrowings” menu option. Member has the option to request an extension to the due date by clicking the “E” button in the action column. Based on the Librarians approval, an extension may be offered to the borrowed books.

My Borrowings

Borrowings List

Reservation ID	Cover	ISBN	Book Title	Borrowed Date	Due Date	Status	Action
86		8174465014	Business Communication	2015-02-22 15:49:01	2015-03-08 15:49:01	Approved	E
89		0470465077	Oracle 11g For Dummies	2015-02-22 21:00:55	2015-03-08 21:00:55	Approved	E


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The Online Library System is inbuilt with a recommendation book engine which suggests books to the members based on three broad categories below:

Book Suggestions

Most Viewed Books

Books from reserved categories

Books preferences

Most Viewed Books:

Based on the most viewed books by all the members of the library, online library system suggests a list of books. The accuracy of this will improve with the increase of book inventory and the number of members.

Books from reserved categories and Books preferences:

Based on the reservations and the categories browsed, online library system suggests books to the members. This essentially means that for each item, Library system builds a neighborhood of related items; whenever a member reserves or borrows a book, Online Library System recommends books from that book's neighborhood.

Librarian

The moment a Librarian logs in to the system, a Dashboard will be visible with key indicators to the Librarian.

The screenshot displays the Librarian Dashboard for the Online Library System. The interface includes a sidebar with navigation options: Dashboard, Book Management, and Patron Management. The main content area is titled 'Dashboard' and features a 'Quote of the Day' by Anne Frank. Below the quote, there is a table of reservation approvals with the following data:

ISBN	Title	Member	Requested Date	Action
1118059379	Beginning Oracle Application Express	Piyal Silva	2015-02-22 15:40:35	Approve Reject
1590335260	Computer Games	Shanaka De Silva	2015-02-22 23:22:47	Approve Reject
1935589679	A Guide to the Project Management Body of Knowledge (PMBOK® Guide)	Daham Silva	2015-02-22 12:21:09	Approve Reject
1935589679	A Guide to the Project Management Body of Knowledge (PMBOK® Guide)	Piyal Silva	2015-02-22 15:39:00	Approve

The Librarian can use the dashboard to perform activities much faster and easier.

Dashboard

You are logged in as Librarian

Quote of the Day
How wonderful it is that nobody need wait a single moment before starting to improve the world.
Anne Frank

Reservation Approvals

ISBN	Title	Member	Requested Date	Action
0313338116	Madonna	Daham Silva	2015-02-22 12:20:45	Approve Reject
0470465077	Oracle 11g For Dummies	Rtt Dfgf	2015-02-22 15:17:41	Approve Reject
1118059379	Beginning Oracle Application Express	Piyal Silva	2015-02-22 15:40:35	Approve Reject
1935589679	A Guide to the Project Management Body of Knowledge (PMBOK® Guide)	Daham Silva	2015-02-22 12:21:09	Approve Reject
1935589679	A Guide to the Project Management Body of Knowledge (PMBOK® Guide)	Piyal Silva	2015-02-22 15:39:30	Approve Reject

OPEC (online public access catalog) - Book Cataloging

This is one of the main features of the Online Library System. OPEC (online public access catalog) is used to extract details about a book and publish the same to the available fields in the Online Library System using Google OPEC API & Dissertations

This feature will reduce librarian's data entry drastically and eliminate errors.

Book Cataloging

Cataloging Form

ISBN: 1118497236

Published Date: 2013-04-22

Pages: 408

No of Copies: 5

Shelf: 1

Language: English

Cost: 4000

Authors: Stanley E. Portny

OPAC Subject (Not required): Business & Economics

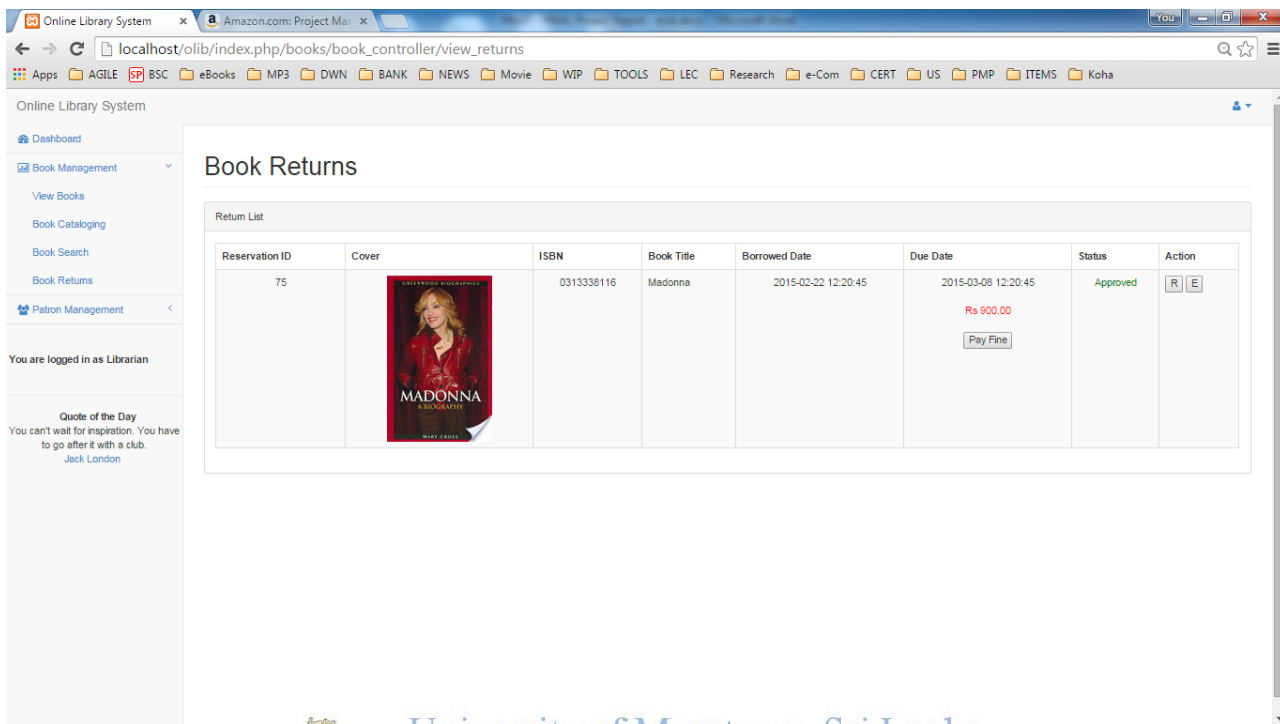
Subject: Computer & Technology Books

Sub-Subject: General

Description: In today's business world, tight project deadlines and stringent expectations are the norm. This hands-on guide introduces you to the principles of project management and show you how to put them to use so you can successfully manage a project from start to finish.

Book Returns:

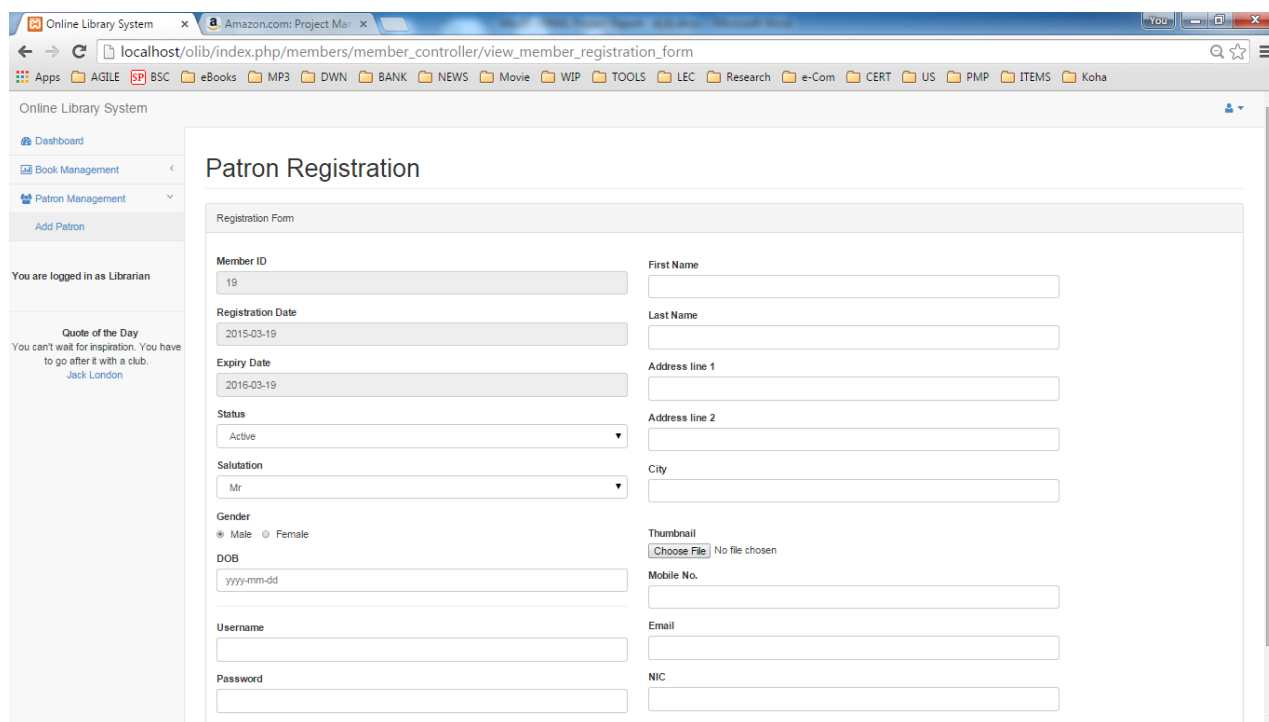
When a member returns a book/s this is the menu item a librarian will use to accept this book and update the nook inventory.



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Member Registration

This screen is used for member registration tasks.



Passed due books - Report

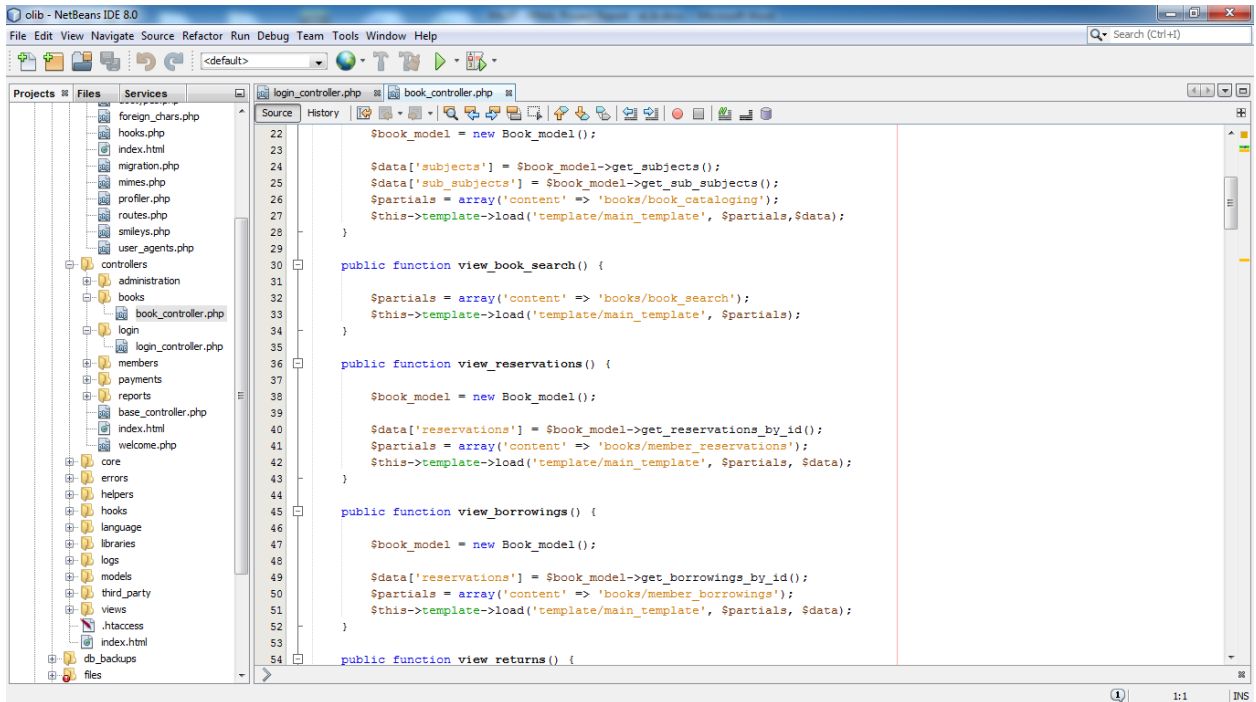
The screenshot shows a web browser window displaying an 'Online Library System' report. The browser's address bar shows the URL: localhost/olib/index.php/reports/report_controller/passed_due_books. The page title is 'Passed Due Books'. On the left, there is a navigation menu with options: Dashboard, Book Management, Patron Management, and Reports. Under 'Reports', 'Passed Due Books' is selected. Below the menu, it says 'You are logged in as Librarian'. A 'Quote of the Day' is displayed: 'Wisdom outweighs any wealth. Sophocles'. The main content area is titled 'Books and Members List' and contains a table with the following data:

Member ID	Name	Book ID	ISBN	Title	Borrowed Date	Due Date	Fine
9	Daham Silva	52	0313336116	Madonna	2015-02-22 12:20:45	2015-03-08 12:20:45	Rs.1000.00
2	Rtt Dfjg	40	0470465077	Oracle 11g For Dummies	2015-02-22 15:17:41	2015-03-08 15:17:41	Rs.1000.00
18	Shanaka De Silva	44	8174465014	Business Communication	2015-02-22 15:49:01	2015-03-08 15:49:01	Rs.1000.00
18	Shanaka De Silva	40	0470465077	Oracle 11g For Dummies	2015-02-22 21:00:55	2015-03-15	Rs.400.00



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6.3 Code snippets

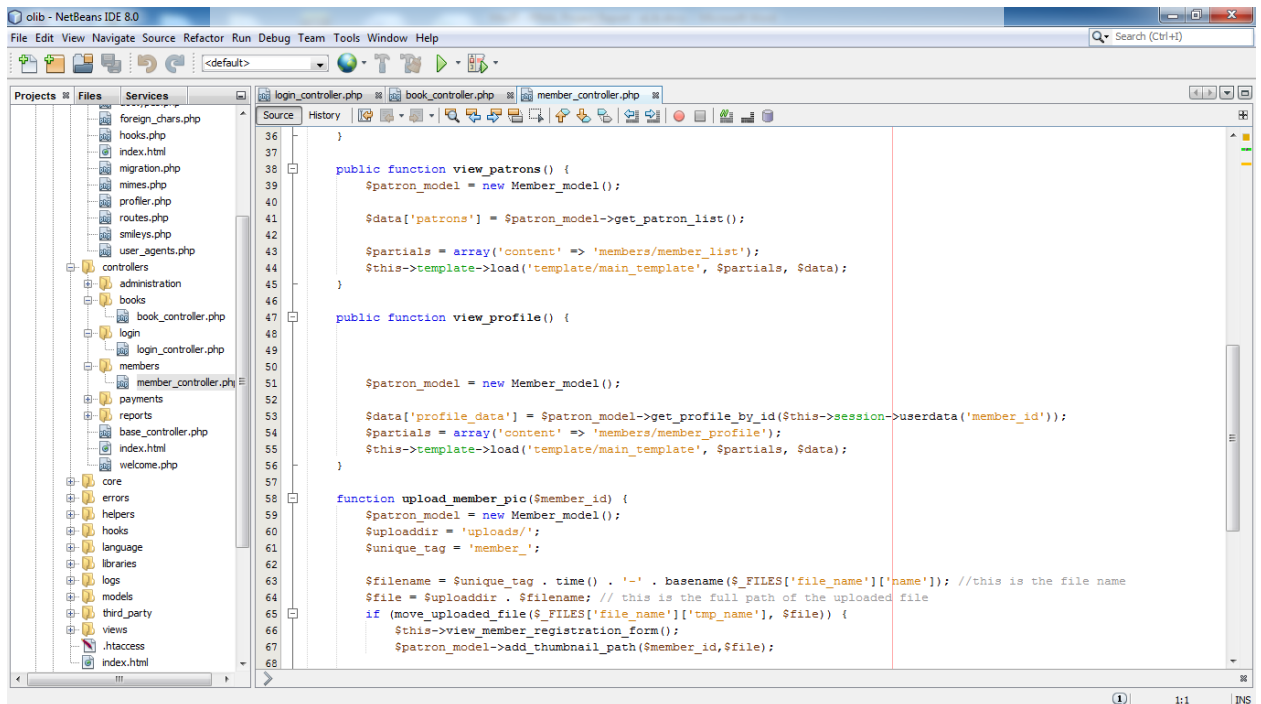


The screenshot shows the NetBeans IDE interface with the 'book_controller.php' file open. The code defines several public functions for handling book-related requests. The 'view_book_search()' function sets up data for a search page. The 'view_reservations()' function sets up data for a reservations page. The 'view_borrowings()' function sets up data for a borrowings page. The 'view_returns()' function is partially visible at the bottom.

```
22 $book_model = new Book_model();
23
24 $data['subjects'] = $book_model->get_subjects();
25 $data['sub_subjects'] = $book_model->get_sub_subjects();
26 $partials = array('content' => 'books/book_cataloging');
27 $this->template->load('template/main_template', $partials,$data);
28
29
30 public function view_book_search() {
31
32     $partials = array('content' => 'books/book_search');
33     $this->template->load('template/main_template', $partials);
34 }
35
36 public function view_reservations() {
37
38     $book_model = new Book_model();
39
40     $data['reservations'] = $book_model->get_reservations_by_id();
41     $partials = array('content' => 'books/member_reservations');
42     $this->template->load('template/main_template', $partials, $data);
43 }
44
45 public function view_borrowings() {
46
47     $book_model = new Book_model();
48
49     $data['reservations'] = $book_model->get_borrowings_by_id();
50     $partials = array('content' => 'books/member_borrowings');
51     $this->template->load('template/main_template', $partials, $data);
52 }
53
54 public function view_returns() {
```



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The screenshot shows the NetBeans IDE interface with the 'member_controller.php' file open. The code defines public functions for handling member-related requests. The 'view_patrons()' function sets up data for a patrons list page. The 'view_profile()' function sets up data for a member profile page. The 'upload_member_pic()' function handles the upload of a member's profile picture.

```
36
37
38 public function view_patrons() {
39     $patron_model = new Member_model();
40
41     $data['patrons'] = $patron_model->get_patron_list();
42
43     $partials = array('content' => 'members/member_list');
44     $this->template->load('template/main_template', $partials, $data);
45 }
46
47 public function view_profile() {
48
49     $patron_model = new Member_model();
50
51     $data['profile_data'] = $patron_model->get_profile_by_id($this->session->userdata('member_id'));
52     $partials = array('content' => 'members/member_profile');
53     $this->template->load('template/main_template', $partials, $data);
54 }
55
56
57
58 function upload_member_pic($member_id) {
59     $patron_model = new Member_model();
60     $upload_dir = 'uploads/';
61     $unique_tag = 'member_';
62
63     $filename = $unique_tag . time() . '-' . basename($_FILES['file_name']['name']); //this is the file name
64     $file = $upload_dir . $filename; // this is the full path of the uploaded file
65     if (move_uploaded_file($_FILES['file_name']['tmp_name'], $file)) {
66         $this->view_member_registration_form();
67         $patron_model->add_thumbnail_path($member_id,$file);
68     }
```

Chapter 7 - Evaluation

The testing of the BookBase Library System have been conducted in four 4 main areas of the system as given below.

1. Black Box Testing:

The main purpose of the testing is to test the architecture of the office management application. The application core has been tested in the black box testing.

2. User Interface Testing:

Verifies the design Interface has been developed throughout the office management system. Checks functionality of the in interface is working as we expected. It the interface is user-friendly, since the prototyping has been used it is must to see the user interface is same as the way we showed to users and get signed.

3. Functional Testing:

Overall system with functions will be tested. Document sharing, meeting management and IT help desk should work together as it has been designed.



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4. Acceptance Testing:

User perspective of the system's quality.

The test cases have been created in line with the requirement specifications and system design. The relevant test cases are described under below sections.

7.1 Black Box Testing

Following test cases have been defined in order to test the application core architecture. The tests are usually carried out by the high level system owners of the application.

No.	Test Objective	Description
1	Whether the application could be installed as specified.	Perform installations of the application on Windows 7 and Windows XP with XAMPP Server simulation software kit.
2	Check whether the application could be brought up as expected	The Application and database should be able to start up through the XAMPP Console.
3	Whether the database and application interacts with each other	Check whether sample data keyed into the application would get stored in the tables of the database. Perform input, modification and deletion of data for all tables.
4	Check the Background processes are working optimally	Checks whether the background jobs have been written in the system are working correctly.
5	Checks the user Access (roles) level works as designed	Performs the login test with each user roles assigned to the users and see the user have their credential as set in the user role file. This is one of the major testing to see the specific controls only access by the designated users only.

Table 4 - Black Box Testing

7.2 White box testing

White box testing (also called structural testing and glass box testing) is testing that takes into account the internal mechanism of a system or component.

Testing focuses on the internal structure of the software code. The white box tester (most often the developer of the code) knows what the code looks like and writes test cases by executing methods with certain parameters.

7.3 User Interface Testing

This is a predominantly application level testing in order to check whether all user interfaces of the client application are working fine. User interface is one of the key to the stability of the environment as unstable interfaces might lead to garbage coming into the environment.

No.	Test Objective	Description	Result	Sign Off
1	Log on screen	Checks the log in screen is validating a correct user credentials. Mainly the User Id and the Password.		
2	Dashboard with available menus	Check the correct menus are displaying with the user credentials set in the user roles.		
3	Media Search Function (Shared Function)	Test the activities available for searching books are working. Check all necessary messages, are displaying.		
4	Media Reservation Function (Student/Faculty Function)	Test the activities available to the reserve books functions are working. Check all necessary messages, are displaying.		
5	Account Status Check Function (Student/Faculty Function)	Test the activities available to the Account status functions are working. Check all necessary messages, are displaying.		
6	Overdue Fee Payment Function (Student Function)	Check whether the activities available for Overdue book handling		

		and payment processing are working.		
7	Media Check in/Check out Functions (Library Staff Function)	Check whether the activities available for Lend and Borrow functions are working.		
8	Report Generation Function (Library Staff and Administrator Function)	Check whether all reports present with correct values and formats		

Table 5 - Test Cases – User Interface Testing

7.4 Functional testing

The functional tests are carried out in order to check the entire system functionality. Generally this could be handled with the participation of administrators and end users. The functional testing would attract the highest user participation.

No.	Test Objective	Description	Result	Sign Off
1	User Id creation function	Administrator/Librarian can only create the users. Should be created users with right credentials that the users are assigned to.		
2	User Change Password function	The user only can change his/her password. Once changed, the system automatically log-out the user. User should login to the system again and perform few frequent functions to see whether the tasks can be performed.		
3	Edit profile function	Users to the system can amend their own profile. Few fields such as NIC		

		number, membership number, registered date, expiry date cannot be amended.		
4	View Book details function	Librarian and members can view book details via system interface. Books are divided in to categories. Librarian will see additional columns such as no of copies of a books, cost of a book.		
5	Book reservation function	Library Member can reserve a book by pressing the “Reserve” button at the bottom at each book. A member can reserve up to a maximum of 3 books.		
6	Book Search function	To search a book, “Book Search” menu option can be used. Multiple search criteria are available to the Library Member such as search using Title, ISBN or Author. Search can be made to the local library books or to internet book sites via OPAC (online public access catalog).		
7	My Reservations function	To view all the pending reservations, Library Member can use the “My Reservation” menu option. Member has the option to cancel the reservations by clicking		



		the “X” button in the action column		
8	My Borrowings function	To view all the books borrowed, Library Member can use the “My Borrowings” menu option. Member has the option to request an extension to the due date by clicking the “E” button in the action column. Based on the Librarians approval, an extension may be offered to the borrowed books.		
9	Book Suggestions function	The Online Library System is inbuilt with a recommendation book engine which suggests books to the members based on three broad categories.		
10	Book Suggestions function - Most Viewed Books	<p>Based on the most viewed books by all the members of the library, online library system suggests a list of books. The accuracy of this will improve with the increase of book inventory and the number of members.</p> <p>Books from reserved categories and Books preferences:</p> <p>Based on the reservations and the categories browsed, online library system suggests books to the members. This essentially means that for each item, Library system builds a neighborhood of</p>		




		related items; whenever a member reserves or borrows a book, Online Library System recommends books from that book's neighborhood		
11	OPEC (online public access catalog) - Book Cataloging	<p>This is one of the main features of the Online Library System. OPEC (online public access catalog) is used to extract details about a book and publish the same to the available fields in the Online Library System using Google OPEC API.</p> <p>This feature will reduce librarian's data entry drastically and eliminate errors</p>		
12	 <p>Book Returns</p>	<p>When a member returns a book/s, this is the menu item a librarian will use to accept this book and update the book inventory</p>		
13	Member Registration	This screen is used for member registration tasks		

Table 6 - Test Cases – Functional Testing

7.5 Acceptance testing (User Acceptance Testing – UAT)

The key purpose of UAT is not to see that a program or system works according to the specification but to check that it will work in the context of a business or organisation.

UAT is testing the integration of a computer system into a much larger system called the business or organisation. It is a form of Interface Testing and is concerned with checking communication between the system and the users. This does not mean it is a form of Usability testing, which checks how easy it is to work with a computer system. Instead it is about whether a business or organisation can input the information they need to and get back usable results which will enable the business to go forward.

Does functionality work in business scenarios?

This is the one of the most important objectives and is the one on which a system can succeed or fail. The testing involves developing a set of business scenarios which the system is expected to deal with and then running them against it.

Using the Library System, one of the scenarios might to "Lend a Book". Developing this Business Scenario shows the End Goal is that one or more books is lent to a borrower. Outlining the main stages for the main goal could be:

Check the library user's details and books they have out.

Check the book details to see if it could be lent.

Create a borrowing record.

This can then be developed into a full Use Case for the scenario. But even this outline indicates a number of paths depending on the number of books a user wants out compared with what they have already, along with failure paths for the various checks, all of which have operational significance.

Has all functionality been specified?

Whether all the functionality has been specified correctly in the system? It is a fact that many of the most important faults in systems are missing or badly specified functionality. And these faults are in the system before coding or configuration of a package occurs. Obviously testing will find these faults, but as they are in the requirements and specifications, they can be discovered earlier in the project by analysing requirements, developing scenarios and reviewing documents.

This emphasises the need for the UAT team to be involved from the beginning of a project and not brought in at the point when System Testing has completed.


Does specified functionality work?


Although the main aim is to see if the system works in business scenarios there is still a need to check if the system works correctly. How much effort is used for this depends on the quality and results from System Testing.

If the system is delivered to UAT on time with a completed system tests, showing what tests have been performed, the number of incidents recorded and the outstanding status of those incidents then one could just check the results of running the business scenarios.

7.6 Evaluate System

Finally quality of the software must be assessed in accordance with acceptable standards,

	 Criteria University of Moratuwa, Sri Lanka. Electronic Theses & Dissertations www.lib.mrt.ac.lk	Excellent	Good	Satisfactory	Weak
Reliability Measure if product is reliable enough to sustain in any condition. Should give consistently correct results. Product reliability is measured in terms of working of project under different working environment and different conditions.					
Maintainability Different versions of the product should be easy to maintain. For development it should be easy to add code to existing system, should be easy to upgrade for new features and new technologies time to time. Maintenance should be cost effective and easy. System be easy to maintain and correcting defects or making a change in the software.					
Usability This can be measured in terms of ease of use. Application					

	<p>should be user friendly. Should be easy to learn. Navigation should be simple.</p> <p>The system must be easy to use for input preparation, operation, and interpretation of output. Provide consistent user interface standards or conventions with our other frequently used systems. Easy for new or infrequent users to learn to use the system.</p>				
	<p>Portability</p> <p>This can be measured in terms of Costing issues related to porting, Technical issues related to porting, Behavioral issues related to porting.</p>				
	<p>Correctness</p> <p>Application should be correct in terms of its functionality, calculations used internally and the navigation should be correct. This means application should adhere to functional requirements.</p>  <p>University of Moratuwa, Sri Lanka. Electronic Theses & Dissertations www.lib.mrt.ac.lk</p>				
	<p>Efficiency</p> <p>To Major system quality attribute. Measured in terms of time required to complete any task given to the system. For example system should utilize processor capacity, disk space and memory efficiently. If system is using all the available resources then user will get degraded performance failing the system for efficiency. If system is not efficient then it cannot be used in real time applications.</p>				
	<p>Integrity or security</p> <p>Integrity comes with security. System integrity or security should be sufficient to prevent unauthorized access to system functions, preventing information loss, ensure that the software is protected from virus infection, and protecting the privacy of data entered into the system.</p>				

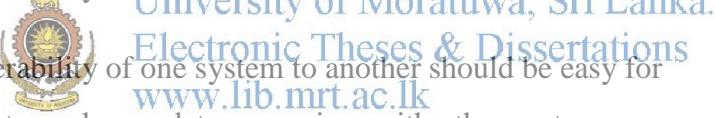
	<p>Testability</p> <p>System should be easy to test and find defects. If required should be easy to divide in different modules for testing.</p>				
	<p>Flexibility</p> <p>Should be flexible enough to modify. Adaptable to other products with which it needs interaction. Should be easy to interface with other standard 3rd party components.</p>				
	<p>Reusability</p> <p>Software reuse is a good cost efficient and time saving development way. Different code libraries classes should be generic enough to use easily in different application modules. Dividing application into different modules so that modules can be reused across the application.</p>				
	<p>Interoperability</p>  <p>Interoperability of one system to another should be easy for product to exchange data or services with other systems. Different system modules should work on different operating system platforms, different databases and protocols conditions.</p>				
	<p>Quality of interfaces</p>				

Table 7 - Evaluate system Testing Metrix

Testing is vital for the smooth functionality of any application. Testing must be carried out with all stakeholders i.e. both library members and internal library staff. Testing is a rigorous and time consuming exercise. There were many obstacles to complete the testing. Major challenge was the time, and the commitment given by the stakeholders.

7.7 Usability Evaluation

Using the available functionality of the system, a questionnaire has been developed to evaluate the usability of the system. The three main user roles provided the feedback (respondents) to the questionnaire.

Usability testing is a technique used in user centered interaction design to evaluate a product by testing it on users. This can be seen as unique usability practice, since it gives direct input on how real users use the system. This is in contrast with usability inspection methods where experts use different methods to evaluate a user interface without involving users.

Usability testing focuses on measuring a human-made product's capacity to meet its intended purpose. Examples of products that commonly benefit from usability testing are foods, consumer products, website and web applications.

In the BookBase Library system there are three user roles.

1. Administrator User role
2. Librarian User role
3. Library Member User role

To perform the usability evaluation, different user roles were selected and distributed the feedback form to be filled using the system and their designated user functions. Usability matrix has been designed with three four categories of Easy, Moderate, Difficult and Not available. These categories will be assigned with a weight of Easy = 10, Moderate = 8, Difficult = 5 and Not available = 0.

User: Administrator

#	Functionally	Easy	Moderate	Difficult	Not Available
1	Create Users	✓			
2	Change User Password	✓			
3	System Backup	✓			
4	System Restore	✓			
5	Report		✓		
6	User Logging	✓			
7	User management	✓			
8	Grant/ Revoke privileges		✓		
9	Monitor logs		✓		
10	Manage Security	✓			
11	Database Tuning	✓			

Table 8 - Usability Evaluation feedback for Administrator


Total Weight assigned to Administrator = $10 * 11 = 110$

Actual Points given by the administrator = $(10 * 8) + (5 * 3) = 95$

Percentage of the Usability function = 86%

User: Librarian

#	Functionally	Easy	Moderate	Difficult	Not Available
1	Lend books	✓			
2	Accept book returns		✓		
3	Manage books	✓			
4	Accept fines				✓
5	Book reservations	✓			
6	Extension approvals	✓			
7	Book sales				✓
8	Manage members	✓			
9	Reports	✓			
10	Change Password	✓			
11	Search book	✓			
12	OPEC interface	✓			

Table 9 - Usability Evaluation feedback for Librarian
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Total Weight assigned to Librarian = $10 * 12 = 120$

Actual Points given by the Librarian = $(10 * 9) + (5 * 1) = 95$

Percentage of the Usability function = 79%

User: Library Member

#	Functionally	Easy	Moderate	Difficult	Not Available
1	Borrow books	✓			
2	Return books	✓			
3	Manage User Profile		✓		
4	Pay fines				✓
5	Online reservations	✓			
6	Online extensions	✓			
7	Online membership	✓			
8	Search book	✓			
9	Change Password	✓			
10	OPEC interface	✓			
11	Reports	✓			

Table 10 - Usability Evaluation feedback for Library Member

Total Weight assigned to Administrator = $10 * 11 = 110$

Actual Points given by the administrator = $(10*9) + (5*1) = 95$

Percentage of the Usability function = 86%

7.8 Resource Requirements

- XAMPP Version 3.x or above (which includes Apache, MySQL and PHP).
- Server operating system: Linux or Windows.
- Web server: Apache (part of XAMPP).
- Programming language: PHP (part of XAMPP).
- Database: MySQL (part of XAMPP).

- Client Software:
 - Requires a recent Internet browser.
 - Mozilla / Google Chrome is advised
 - Mobile Platform (Windows or Android)
 - Certain data validity checks are made on the client machine, JavaScript must be enabled.



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Chapter 8 - Conclusion & Further work

8.1 Conclusion

The work reported in the present thesis was for me a big and great challenge. From the technically point of view, all the goals defined in the beginning of project were, in the majority, reached with success. The completed system has nowadays available at WCMT College to manage physical library book items and automate operations.

The focus of this paper is to identify the pitfalls of the existing system at the organization and general problems exist in off-the-self applications available in the market. A solution is illustrated based on these, which may be carried out to overcome and reduce these problems by introducing state-of-the-art web based library management system to pave the way for users to enjoy the benefits of a highly up-to-date system. The current situation of WCMT Campus library system was described in detail covering the existing issues, in the paper. One reason why WCMT Campus library system was chosen is because the author had a better opportunity and much facility to conduct the research there as being a lecturer in that university.



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The author came up with the idea that a state-of-the-art web based library management system would be the solution to fill the gaps and overcome the existing challenges which ought to be addressed in WCMT Campus library system. Many sections of this thesis is dedicated to a detailed analysis of various methodologies available in the industry to build this library system. This includes internationally accepted matured methodologies ranging from waterfall based to agile based empirical frameworks.

Many challengers were faced with user trainings since the transformation from a character based system to a graphical user interface was somewhat new to the library staff. Many training rounds were conducted to uplift the skills and abilities of the users. Users were initially reluctant to approve the online based features such as online reservations, online payments, online cataloging using OPEC. Finally with the involvement of the top management and the highlighting of the benefits, users agreed to implement the same.

8.2 Further work

After several months of development, and considering the goals of the projects, I think there still having some improvements which need to be done, to improve the features/functionality.

One of the biggest challenges in the implementation at WCMT was the various problems I faced in the data migration from old system. The existing data of the clipper based obsolete system was erroneous and lot of time had to be spent on cleansing activities. This eventually ended up in an incomplete data migration job at the site.

The online help and the user manual could not be completed during the time allocated. I know the importance of such facility and documentation in the context of an application and have taken steps to finish this within a month and provide the same to WCMT College.

Another improvement concerned with the OPAC feature. I have used only few parameters of the OPAC search API provided by google scholar. This can be further enhanced in to many multiple search features and to retrieve much additional information provided by google. This feature can also be used as an alternative way to request books and other type of materials, from other libraries.



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It would be nice to provide an enhancement to the Circulation module with RFID technology. Many libraries worldwide use such technology to improve efficiency and reduce fraud. Further this also will increase the level of automation present in libraries and improve the quality of services provided to the borrowers. I think this will be the future of all the libraries in the next years.

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