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Library Management System

Abstract

The system differs greatly from the traditional library management system, it covers all functions of the traditional system, and it appeals to students and teachers because of its new concept, living library, also known as human library, also, it is very useful due to its multiple features such as micro-message reminder, used book trade, recommendation, etc.  
You can get a detailed critical review of the project from this document.

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# Objectives

The Library Management System aims to provide an online library management for the students and teachers of Jiangsu Second Normal University to search, borrow, return, comment and rate books, also, it aims to build an online community for them to share knowledge, recommend books, as well as trade used books.

The system introduces a new concept called Living Library, also known as Human Library, which started in Denmark that takes human as an education tool or knowledge carrier for people to borrow, you may talk with these borrowed people about their specific areas, skills or experience so that you can get firsthand materials of the theme you want to explore, or fresh impression about the things you’ve learned before, or brand new understanding about a certain kind of people, etc.

The system is designed to make the living library easier to apply, it accepts reservation and allows 2 types of talking with the borrowed people, face-to-face talk and online talk using Skype. It also supports searching, commenting and rating just as the books.

In addition, the system will make it more efficient and convenient for administrators to monitor books, by looking up the rate, comments and borrowed count of the book, they can track users’ needs and take some action to meet the needs. For example, they may collect more demanded books if a book is highly recommended but there are few to lend, or they will consider to buy more books that are the same kind as the hot books.

What’s more, the system will focus on user experience and will promote the usage of the library, for instance, the system will develop a module of notification that combines e-mail, micro-blog, and micro-message (like twitter and MSN) for better user experience and higher usage of the library. It will bring a revolution to the library of Jiangsu Second Normal University.

# Scope and Constraints

The Library Management System provides services of borrowing, renewing, returning, commenting and rating books. It allows students and teachers to borrow living library via its online reservation system. It also builds a platform for trading used books.

The system is not redesigning the old library management system, it will select a few of books that are valuable and useful to suggest a high-quality reading for users. The survey shows that…

For better user experience and higher usage of the library, the system will have its own notification module, it will combine e-mail, micro-blog and micro-message together to make a good reminder for user to manage books.

Due to budget constraint as well as the space constraint of the system, it will not provide user’s personal space in this version, but just a simple page for sample, and this could be a future enhancement of the system.

# 3 Project Details



## Background

Project Background:

Located in Nanjing, Jiangsu province, Jiangsu Second Normal University is a full-time undergraduate school. At present, it has 16 institutes and nearly 7,000 full-time students. In recent years, the university is developing rapidly with enlarging dimensions. However, the traditional library management system is out of date, it’s running slowly, and it’s offline that only provides service inside the library which is a great limit for students who expect to inquire books in and out of the library at any time, as a matter of fact, the old library management system leads to very low usage of the library. Compared with many online systems, the old system lacks interaction with users, and the functions seem to be too simple to meet the various needs of users.

After talking with our sponsor about our observation and ideas, we finally get a support to develop a new library management system for the university.

The system is a not redeveloped library management system, but a new system to attract more students to participate and learn from each other by sharing reading experience and giving guides to green hands. It also brings convenience to students to store personal data (as a future enhancement) and trade their used books. Moreover, they can book human books and get precious inspiration or tutorials because of online living library reservation. On the other hand, compared with the old fashion way, librarians, now play the role of system administrators, are able to interact with users, and manage books more positively and efficiently according to books’ comments and rates. With increasingly participation of students on the new system, more and more students will find their interests in reading and studying. We have the faith that one day, the new system will totally replace the traditional library management system.

Our ideas brain-storming figure:

Sponsor Background:

Located in Nanjing, Jiangsu Province, Jiangsu Second Normal University is a full-time undergraduate school. Covering an area of about 35 hectare, it currently has three campuses of CaoChangMen, PuKou and XiaoYing. Besides normal education, it also opens some majors for Jiangsu economic and social development. At present, it has 16 institutes and nearly 7,000 full-time students. The school has three libraries, collecting about half million books covering almost all subjects. The libraries grow from two locations within 20 staffs to its current three locations within 32 staffs. Each library provides private learning rooms and public learning areas.

Living Library Background:

Living Library, also known as Human Library, is started in Denmark. The core idea is taking human as an education tool or knowledge carrier to enhance people’s participation. These borrowed people may be male and female, old and young, and many of them have controversial social statuses like transgendered people, radicals, AIDS patients, homosexuals, Mohammedans, strippers and alcoholics. People may borrow these living books and talk with them, thus they can learn each other better and reduce the prejudice and discrimination in the society.

## Problem Statement

Although the library management system is still available in Jiangsu Second Normal University, it is out of date. A lot of books are in low rate of usage because of the isolation of system and lack of updated statistics. Users can only browse books inside the library, that is, the old system is offline. There are a lot latest books’ information also need to be updated into the system. The database of the system doesn’t have backup service and the processing speed is low when a lot inquires executed simultaneously.

From the survey (see appendix) which we aim to find out needs for future library management system and drawbacks for the current one, we know that the majority of students think they should be able to search books outside the library and keep up with the information of latest books. They want to share reading experience and rate the books they’ve read just like what they can do at Amazon book market. They also want to have their own space to store personal electric documents. Here is one figure drawn from the survey,

On the other hand, they complain that the current system is boring, too simple to meet the needs, and the UI design is bad, and there is no way to find out the latest or most popular books, that the library doesn’t provide activities or any kind of communication between readers. They expect to get some tutorial or some kind of guide as well. Here is another figure according to the survey,

Based on all the facts of current system and the result of the survey, we decide to develop an online library management system for the JSNU (Jiangsu Second Normal University) which is more suitable for current situation.

Before we start, we ask ourselves some critical questions as the table shows below:

|  |  |
| --- | --- |
| 1 | How to design a reasonable system architecture to make all subsystems work? |
| 2 | How to apply the concept “living library” to a real online platform? |
| 3 | How to design an attractive and user-friendly UI? |
| 4 | How to protect users’ privacy (e.g. Skype ID is only visible when a reservation is completed)? |
| 5 | How to make use of some external APIs (e.g. Java Email service or even SMS service)? |
| 6 | How to build up a reminder to notify users when books are about to overdue, or a reservation has been made or cancelled? |
| 7 | How to design used books trading platform with some suitable restrictions or rules to prevent spamming? |
| 8 | How to sort the books based on rates, popularity, or the number of comments? |
| 9 | How to use some web security strategies to protect the safety of the system? |

Figure 3. Problem Statement

## Solution

Living library is a total new concept for students and teachers in Jiangsu Second Normal University, my sponsors show great interest in this idea and is willing to provide me any useful resources for designing the library (e.g. Study rooms for communication, some candidate teachers may become living books).

As far as I am concerned, there are only two organizations providing service of living library, one is Douglas College, the other is Coquitlam Library. The form of these living libraries is simple. They offer some activities, inviting some typical and critical people (e.g. ex-offenders, HIV carriers and gays) and sort them into different titles of books for people to borrow. After a talk with the living book, readers can learn from their stories or experience, reduce prejudice and remove stereotype.

However, the current living library has some limits (see figure).

Limits

Figure Limits of Living Library

Firstly, there are very few of book categories, most of them are centralized in very critical and typical area. On the other hand, living books related to academic research areas are almost zero. Thus the mode of the traditional living library is not suitable for JSNU. It can hardly make contribution to the students’ academic study.

Secondly, the reservation of traditional living library only stays on massive paper work, it’s isolated and has limited communication form among library administrators, users and living books. It can hardly attract students to participate.

Thirdly, the traditional living library lacks availability. Users can only borrow living books during library’s activities. If there is no activity, there is no chance to borrow any living books. It is inconvenient for students to study constantly.

Fourthly, it is hard for librarians (system administrators) to track performance of each living book due to lack of users’ feedbacks.

Last but not least, the form of using living library is single, it only allows for talking face to face, there are no supports for people chatting via online chatting tools such as Skype or MSN. When the users or the living books encounter time or place problems, chatting online will be a good way to solve the problem.

Above all, the limits show that the current living library is not enough for JSNU, so we think about a solution to apply the living library to our system. That is,

# 4 Architecture

The system makes use of the Java lightweight open source frameworks Struts2, Spring and Hibernate, MySql for database management, Tomcat for web server, and MyEclipse for developing. The architecture of the system is shown as the following figure:

Hibernate support

Struts2 support

Service Layer

Data Layer

Presentation Layer

Figure System Architecture

As shown in the figure, the service layer of the system uses Spring, the data layer uses Hibernate that can be integrated into Spring via supporting classes of Spring. The presentation layer uses Struts2 to pass data and control the web pages written in JSP, EL, and JSTL. The whole system uses the 3 layer architecture, which allows only the upper layer calls the lower layer, so as to achieve loose coupling among layers.

Struts2 framework:

Struts2 is a Web application framework based on MVC. The core meaning of MVC pattern is MVC pattern decoupling, dividing the entire application into three parts, model, view, and controller. It tightly controls the communication between the three parts, in order to obtain a clear-structured, function-distribution-reasonable, reusable, extensible, and maintainable applications. By using Struts2 to control the page jumping, you don’t have to write complex code written in Servlet, the robust value stack and OGNL expressions of Struts2 can be used for transmission and control of data.

For enterprise applications, server-side validation is necessary, strict check should be taken on the user provided data before any business logic codes are called, in tradition, data validation needs programmers writing code to achieve, and often the codes are mixed with business logic codes. However, Struts2 provides a framework for data checking, and you can easily tell which codes are for data validation and which are for business logic because it separates the data validation and the business logic. Also, Struts2 has powerful tag library and filters, all of the factors improve the efficiency for the enterprise application development.

The operation process of Struts2 is very simple, when the user request arrives at FilterDispatcher controller, the controller will execute the corresponding Action according to the submitted URL and configuration in the struts.xml. Struts2 Action realizes the decoupling with Servlet API, Action does not require any class inheritance or interface implementation. After finishing processing the user request, Action will jump to the page that is pre-configured in Result according the processed result, and display the data caught in Action to user.

Hibernate framework:

Hibernate is a persistent software based on Java open source, it encapsulates a lightweight package to provide JDBC, ORM (Object Relational Mapping) service. ORM automatically maps the objects of the program to tables of a relational database according the metadata which describes the mapping between objects and tables of database. If we use JDBC to connect to the database and do some operation on database, we need to write a lot of code, while using Hibernate we only need to configure the mapping between Java entity class and the relational database tables, and the method for Hibernate to query and acquire data, thus reduce the amount of code, and improve the efficiency of development.

Hibernate provides one to many, many to one, many to many relationships of objects association, as well as immediate loading and delayed loading support, which facilitates the manipulation of data. The object-oriented HQL query will generate the corresponding SQL statement according to the mapping relationship between objects and database tables, which simplifies the complex SQL statements writing. Hibernate also provides a 1 level cache and 2 level cache, the rational use of 2 level cache can reduce the number of database access effectively which will enhance the overall performance of the system.

Spring framework:

Spring is a lightweight open-source framework of Java SE/EE application, with IoC (Inverse of Control) and AOP (Aspect Oriented Programming) as the core. Inverse of control is also called dependency injection, it makes the object class a passive receiving dependent class rather than class that need to find service on their own. Dependency injection gives the control of dependencies among objects to Spring, so you don’t need to worry about when to instantiate an object, and just focus on the business logic. Spring also provides a powerful support to the Aspect Oriented Programming, by separating out the business logic from application services, it achieves cohesion development.

To integrate Spring and Hibernate, we can put the SessionFactory interface of Hibernate that manage the data access to the IoC container of Spring, so that we only need configure the file rather than manually create an instance of SessionFactory when Hibernate accesses the database. We can also use the transaction mechanism of Spring, so as to switch different data sources without modifying the source code.

To integrate Spring and Struts2, the instantiating the Struts2 Action no longer needs to be managed by Struts2, but managed by the IoC container of Spring instead, thus we can reduce the coupling procedures, and separate the controller and the business logic, which brings great convenience to future maintenance and expansion.

ExtJs:

ExtJs is an independent of back-end, JavaScript written Ajax framework. The power of ExtJs lies in its various components, you can build rich and colorful front pages use the components. ExtJs form controllers are perfect, they support functions as sorting, caching, draging, hiding and editing data, etc. Form controllers support not only the beautiful appearance but also support data check at the front end. Layout controllers can take charge of the entire page layout without writing a lot of code in JavaScript. In addition, ExtJs can reduce as much as possible of the count of jump pages, or even eliminate the need for page jumping.

MyEclipse:

MyEclipse is a very good J2EE tool for integrated development based on Eclipse, it has powerful collection of plugins supports than Eclipse, and better support the open source products. It is an enterprise level development platform, an extension of Eclipse. In MyEclipse, database and J2EE development can be integrated easily, as for the program compiling, running, testing, deploying and releasing, they can all be finished in MyEclipse. Besides, MyEclipse has a good support for the Java open-source framework like Struts2, Spring and Hibernate. Another commonly used integrated development tool is called Intellij IDE, but it lacks plugins, and occupies large memory. Therefore, we choose MyEclipse as the top tool for J2EE development to speed up the development of J2EE applications.

Optimizations for the system:

* **Apache Tomcat web server and load balancer**



The library management system should allow large number of queries processing parallel, therefore single server cannot satisfy the need of loading, what’s more, if the server fails to do normal operation, the whole system ducks. So we must find out the way to ensure that the system doesn’t crush easily. We choose to use the Tomcat cluster technology to solve the problems.

The Tomcat cluster can be achieved by two or more server software instances running on one or more server computers, the servers together make it transparent to clients, the clients see only a high available service. The reverse proxy cluster system use Apache to achieve load balancing, Apache will do the dispatching work, it receives the client’s request and then forwards the requests to different Tomcat servers, thus make the loading balanced. You can clearly see the working principle of the Tomcat cluster.

集群系统由一台或多台服务器计算机上运行的两个或更多服务器软件实例组成，这些服务器计算机彼此协同合作以透明地服务客户端的请求，从而从客户端角度看，整个集群租是一个高可用性服务。网站的集群系统使用Apache的反向代理来实现负载均衡，Apache会将用户的请求分别转发给不同的Tomcat服务器，以此来实现Tomcat的集群。集群部署图如图所示。

* **Cache of Hibernate**

The cache is located between applications and physical data source at the computer memory, its purpose is to reduce the number of applications accessing to physical data sources, so as to improve the performance of applications. When a program needs to query the database, it will first look up the data in cache, if hit, that is, if find the data, then it will not have to access the database anymore.

* **Partition and creating index for database**

A partition is a division of a logical [database](http://en.wikipedia.org/wiki/Database) or its constituent elements into distinct independent parts. Database partitioning is normally done for manageability, [performance](http://en.wikipedia.org/wiki/Optimization_(computer_science)) or [availability](http://en.wikipedia.org/wiki/Availability) reasons.

The partitioning can be done by either building separate smaller databases (each with its own [tables](http://en.wikipedia.org/wiki/Table_(database)), [indices](http://en.wikipedia.org/wiki/Index_(database)), and [transaction](http://en.wikipedia.org/wiki/Database_transaction) [logs](http://en.wikipedia.org/wiki/Database_log)), or by splitting selected elements, for example just one table. Horizontal partitioning (also see [*shard*](http://en.wikipedia.org/wiki/Shard_(database_architecture))) involves putting different rows into different tables. Perhaps customers with [ZIP codes](http://en.wikipedia.org/wiki/ZIP_code) less than 50000 are stored in CustomersEast, while customers with ZIP codes greater than or equal to 50000 are stored in CustomersWest. The two partition tables are then CustomersEast and CustomersWest, while a [view](http://en.wikipedia.org/wiki/View_(database)) with a union might be created over both of them to provide a complete view of all customers.

Vertical partitioning involves creating tables with fewer columns and using additional tables to store the remaining columns. [Normalization](http://en.wikipedia.org/wiki/Database_normalization) also involves this splitting of columns across tables, but vertical partitioning goes beyond that and partitions columns even when already normalized. Different physical storage might be used to realize vertical partitioning as well; storing infrequently used or very wide columns on a different device, for example, is a method of vertical partitioning. Done explicitly or implicitly, this type of partitioning is called "row splitting" (the row is split by its columns). A common form of vertical partitioning is to split dynamic data (slow to find) from static data (fast to find) in a table where the dynamic data is not used as often as the static. Creating a view across the two newly created tables restores the original table with a performance penalty, however performance will increase when accessing the static data e.g. for statistical analysis.

Creating index for database can improve the speed of data retrieval operations on a [database table](http://en.wikipedia.org/wiki/Table_(database)) at the cost of additional writes and storage space to maintain the index data structure. Indexes are used to quickly locate data without having to search every row in a database table every time a database table is accessed. Indexes can be created using one or more [columns of a database table](http://en.wikipedia.org/wiki/Column_(database)), providing the basis for both rapid random [lookups](http://en.wikipedia.org/wiki/Lookup) and efficient access of ordered records.

# 5 User Requirements

## 5.1 Use Cases

First, we concluded a list of user requirements according to our survey, observation at the library, and talking with some librarians as well, here is what we concluded:

The system is required by these stick-holders: users, administrators, and living books

Users’ Requirements:

1. Users can register with valid student ID through the website.
2. Users can edit personal information.
3. Users can search a book according to its name, category, publish time, press, author, book ID, etc.
4. Users can sort books according to borrowing times, the number of comments or rates.
5. Users can borrow a book via the system; they will received a confirmation letter when they successfully complete a booking, then, they can pick up a book with a valid student ID.
6. Users can renew the borrowed books, however, renewing is only allowed once and duration is a month.
7. Users can rate and comment books when they successfully return books.
8. Users can post sale information of used books by simply clicking “I want to sell used books”.
9. Users can post demand information of used books by simply clicking “I want to buy used books”.
10. Users can search used books.
11. Users can upload pictures of used books.
12. Users can edit or delete their posted information.
13. Users can contact a buyer or seller by clicking “contact” button and they can communicate by emails. For protection of privacy, real email addresses of buyers and sellers should be hidden by using anonymous email addresses.
14. Users can search human books according to different subjects (e.g. math, computer, history, and physics).
15. Users can sort human books according to borrowing times, the number of comments or rates.
16. Users can borrow a human book via the system and choose its available schedule; two forms of meeting is optional for users: online meeting (via Skype) or offline meeting.
17. Users submit meeting form and meeting theme before booking living book.
18. Users can contact wanted human books by simply clicking “contact” button. They can communicate by email. For protection of privacy, real email addresses of buyers and sellers should be hidden by using anonymous email addresses.
19. Users can cancel a booking.
20. Users can rate and comment human books when they finished reading.

Administrators’ Requirements:

1. Administrators can add, delete and edit books
2. Administrators can delete over-offensive comments.
3. Administrators can confirm a booking when users pick up with a valid student ID, however, a booking is only hold up 48 hours before its cancelation.
4. Administrators can confirm a returning of books when they receive them.
5. Administrators can delete posts irrelevant to the used books.
6. Administrators can add human books, delete human books or edit information of human books.
7. Administrators can add users to blacklist based on following situations:
   1. Users don’t return books or don’t return books on time.
   2. Users often post junk information irrelevant to used books.
   3. Users often fail to keep the appointment with reserved human books.
   4. Users often cancel the meeting with human books.
   5. Users often post malicious comments.

Living Books’ Requirements:

1. Living books can edit personal information. (Such as the title, subject, special filed, interests, introduction, available schedule for booking, reading forms, contact information and etc.).
2. Living books can cancel the reservation made by users.
3. Living books can comment the users.
4. Living books can send and receive the letter inside station.

With the conclusion list of the requirements, we analyze them using UML and try to make it clearer for the system to be understood, in this phrase, we find that the notification of system should be put on the table to meet the needs. In UML, such a **notification of system** is also treated as a user. Here are what we analyzed in UML:



Figure Users' Use Case

As it shows in the figure, users mainly have 4 use cases, borrow books, borrow living books, trade used books, and manage personal information, these 4 cases have extended cases, or son cases, and some of them share one or more extended cases because of the same logic. Then we analyze each case, mainly the stimulation and respond sequence of the use case.

**Stimulation/Respond Sequence:**

1. User searches a book by the category, title, publishing time, author, ISBN etc.
   1. The system shows the result of searching in a list
2. User sorts books according to the reading count, rating score, and the adding time.
   1. The system gives out the sorting result
3. User borrows a book online
   1. The system checks if the user could borrow
   2. If so, sends a success message to the user
   3. If not, sends a failure notification to the user.
4. User renews a borrowed book
   1. The system checks if the user could renew the book
   2. If so, sends a success message to the user
   3. If not, sends a failure notification.
5. User collects a book
   1. The system checks if the book is already in the collection of the user
   2. If so, sends a notification
   3. If not, add the book to its collection list.
6. User comments a book
   1. The system checks if the user could comment the book (the user is not in the blacklist)
   2. If so, add the comments to the book
   3. If not, gives out a notification to the user.
7. User reserves the living book
   1. The system checks if the reservation is valid (all required information are filled and valid, and the user is allowed to make a reservation, that is, the user is not in the blacklist)
   2. If so, sends a success message to the user and the living book ( the message includes the meeting time, meeting form, the theme to be discussed, Skype ID if meeting form is online, room number if meeting form is offline )
   3. If not, sends a notification to the user.
8. User cancels the reservation
   1. The system checks if it is 6 hours ahead of the reserved time
   2. If so, cancel the reservation, sends a success message to the user and the living book
   3. If not, gives a notification to the user that he may not cancel it.
9. User posts used book for sale
   1. The system checks if the information is valid and completed (title, ISBN, author, quality, price, etc.)
   2. If so, post it to the page of used book trading
   3. If not, gives hints to the user
10. User posts used book for purchase
    1. The system checks if the information is valid and completed (title and author)
    2. If so, post it to the page of used book trading
    3. If not, gives hints to the user
11. User communicates with the other user on the used book trading platform
    1. The system pops a dialog to require the sending content

11.1 User fill in the blank and click send

* 1. The system will send a letter inside station and an e-mail as well to the other user and his default mailbox

1. User registers
   1. The system shows a page to require the basic information of the user ( name, birthday, gender, student number or faculty number, hobby, email address, Skype ID, password and the questions of finding password)

12.1 User fills in the blank

* 1. The system checks if the information is valid and completed
  2. If so, the system sends out a success message to the user
  3. If not, sends a notification to the user

1. User logs in
   1. The system checks if the name and password are correct
   2. If so, jumps to the page with user information
   3. If not, gives hints to user for incorrect name or password
2. User logs out
   1. The system save the data of the user and jumps to the default page without user information
3. User modify personal information
   1. The system checks the information and saves the modified information



Figure Administrators' Use Cases

So administrators mainly do the management work, they manage books, living books, posts, comments and users, often the management work deals with adding, deleting, modifying data, so is the work in our system, and there’s no need to illustrate any more, what we focus on is some special operations admins can do in our system, we analyze these operations with stimulation and respond sequence shown as below.

**Stimulation/Respond Sequence:**

1. Admin confirms a borrowing after checking the users’ status
   1. The system checks the book’s state then shows a message of success or notification
   2. If the book is borrowed, and the user doesn’t come to fetch, then the system will cancel the borrowing, that is, without a confirmation of admin within **2 days**, the borrowing will be canceled automatically by system
2. Admin confirms a returning after checking the book
   1. The system will modify the book’s state and shows a message
3. Admin adds users to blacklist
   1. The system shows a list of blacklist with add and remove buttons

3.1 Admin clicks add button

* 1. The system pops a dialog to require the user’s ID

3.2 Admin enters the user id

* 1. The system searches the user id, shows the information of the user

3.3 Admin clicks confirm button

* 1. The system adds the user to its blacklist, and the user is now shown on the list



Figure Living Books' Use Cases

The living books use the system in a simple and straight way, they only need do the interaction with the user and manage their personal information especially their time tables which are very important for the whole process of borrowing living books. The modify information case has one special feature, that’s the time table, how to design the time table to make it easy for living books to modify and for users to select is critical, but on this phrase, we don’t need to care about that. The comment user case is just like what it does in the Users’ Use Case, so we don’t analyze repeatedly. The cancel reservation case is the same as what a user does in canceling a reservation except the time limit, the stimulation and respond sequence is:

Living book cancels the reservation,

1. The system checks if it is 2 hours ahead of the reserved time
2. If so, cancel the reservation, sends a success message to the user and the living book
3. If not, gives a notification to the living book that he may not cancel it.

As for the send and receive letter inside station case, actually it is a feature of the system, that is, all the users, admins and living books can use the letter inside station, but we put it here to press the duty to interact with users of living books.



Figure Notification Use Cases

This is what we concluded from the stick-holders’ statements and the systems’ features, for better user experience, we put the notification system on table, we hope that we can notify users in time, so the letter inside station and email are not enough, we think about combining the micro-message and the system, so that when there are books to be overdue or a reservation cancelled, the users and the living books can get a timely message with the notifications.

# 6 Detailed Design

With the analysis of the user requirements and architecture as well, we now move on to the phrase of detailed designing, the system has 4 layers, namely are presentation layer, service layer, logic layer, and data layer, and we build these 4 layers with SSH (Struts2, Spring and Hibernate) framework.

The data layer includes models and DAO. Models are the data structure, or the single objects for the system to pass and process. Let’s take the model of book for example, its private properties like author, press, title, ISBN are the corresponding keys of the book table in the database, and its methods are getters and setters for these data properties like getAuthor, setAuthor, getPress, setPress, getTitle, setTitle, getISBN and setISBN, etc.

We use class diagram to illustrate the model design. Here’s the figure:



Figure class diagram for model

DAO is for data access object, which is responsible for accessing data of the database, in the system, we make use of Hibernate framework to support DAO.



Figure Class Diagram For DAO

Logic Layer is for the business logic, it’s the core of the system, and it uses the resources of the system to make the system work like the real world. In the Library Management System, we name the layer Action out of habit. Action does the logical operations on the data by the support of Spring and Struts2, here’s what we designed:



Figure Class Diagram for Logic Layer

Service layer is responsible for the interaction between logic layer and data layer, supported by Spring. It decouple the layers and make the system clear and maintainable. Here’s what we designed on the service layer:



Figure Class Diagram for Service Layer

Finally, the presentation layer deals with UI and calls the logic layer, we use Struts2 for support. Since we use Dynamic Web Project in MyEclipse to develop the system, we need to add tags to the *web.xml* file under the WEB-INF folder:

|  |
| --- |
| <filter>  <filter-name>struts2</filter-name>  <filter-class>org.apache.struts2.dispatcher.ng.filter.StrutsPrepareAndExecuteFilter</filter-class>  </filter>  <filter-mapping>  <filter-name>struts2</filter-name>  <url-pattern>/\*</url-pattern>  </filter-mapping> |

Figure Add tags to support Struts2

# 7 Development Process

## 7.1 Version 1.0 – Groundwork

**Goal**

The Goal for this iteration is creating a foundation for further development. It includes technology choosing, setting up framework and integrating with each other for whole system, and then basic functions of login service to make sure system work stable and well-connected.

**Details**

**Chosen Development technology and tools**

SSH framework



Figure Division of tasks of SSH framework

**Integration of Spring framework and Hibernate framework**

It is easy to integrate Spring framework with Hibernate because of its extensibility and openness. Spring framework provides unified management of data source. Instead of configuring configuration file - **hibernate.cfg.xml** in the Hibernate, it only needs to configure data source and control attributes for the Hibernate in the **applicationContext.xml** file in the Spring. Meanwhile, in order to easy to use, Spring framework provides Hibernate Template which can easily control database without tedious work. In Spring, database connection and transaction management all begin with setting up SessionFactory. SessionFactory only requires one instance in the application, so the instance can be created by Spring and injected into related dependent objects. The Code for configuration file is as follows:

|  |
| --- |
| <!—configure Hibernate database source -->  <bean id="dataSource" class="org.apache.commons.dbcp.BasicDataSource" destroy-method="close"  <!-- get database connection information from configuration file -->  p:driverClassName="${jdbc.driverClassName}"  p:url="${jdbc.url}"  p:username="${jdbc.username}"  p:password="${jdbc.password}" />  <!-- instantiate SessionFactory-->  <bean id="sessionFactory" class="org.springframework.orm.hibernate3.LocalSessionFactoryBean"  <!-- reference data source -->  p:dataSource-ref="dataSource"  <!-- specify mapping files of Hibernate -->  p:mappingDirectoryLocations="classpath:/com/books/domain">  <property name="hibernateProperties"><props>  <!-- set the dialect of Hibernate -->  <prop key="hibernate.dialect">  org.hibernate.dialect.MysqlDialect  </prop>  <!-- background output SQL statements operated by Hibernate and format -->  prop key="hibernate.show\_sql">true</prop>  <prop key="hibernate.format\_sql">true</prop>  </props></property></bean>  <!-- configure HibernateTemplate -->  <bean id="hibernateTemplate"  class="org.springframework.orm.hibernate3.HibernateTemplate"  p:sessionFactory-ref="sessionFactory" /> |

Figure Configure Hibernate into Spring

**Integration of Spring framework and Strus2 framework**

Spring not only offers an outstanding open source MVC framework referred as SpringMVC, but also supports well of integration with other web frameworks. During the integration of Spring and Struts2, the main step is making Spring’s IOC container manage Struts2’s Action, then the Action classes of Struts2 are able to require their instances through Spring. Before the integration, in Struts2’s configuration file - **struts.xml,** we need to convert Struts2’s request processor to Spring’s request processor, and upload ApplicationContext when starting Web. In addition, using comment @Controller can realize class injections for these Action classes need to be injected. Configuration code of web.xml is as follows:

|  |
| --- |
| <context-param>  <!—configure applicationContext.xml for files upload paths-->  <param-name>contextConfigLocation</param-name>  <param-value>/WEB-INF/applicationContext\*.xml</param-value>  </context-param>  <!—use ContextLoaderListener(from Spring) to create ApplicationContext-->  <listener>  <listener-class>  org.springframework.web.context.ContextLoaderListener  </listener-class></listener> |

Figure Configure Spring into Struts2

**Tomcat server**

Tomcat server is a lightweight application server, and it is widely used to handle the normal amount of concurrent accesses in small or medium system. It is also the first choose for debugging JSP program. Moreover, Tomcat server has good compatibility and supported by many well-known software companies. It runs stable and has a good development prospect. Deployment diagram of Tomcat server for this system is as follows:



Figure Deployment of Tomcat server

The following steps are the installation of Tomcat server in MyEclipse:

1. In MyEclipse, open display window from window – show view – servers, as shown in figure:



Figure open window from the menu

2. Right click New – server in Servers window, it will let you to select version of Tomcat:



Figure select version of Tomcat server

3. After done select version, click Next to access the place where to add directory for Tomcat server, then choose the proper directory and change JRE to JRE6, as shown in figure:



Figure add directory for Tomcat server

4. After adding directory, click Next to the place where to upload project to Tomcat, choose the proper project and click Fish, as shown in figure:



Figure upload the project to the server

**MySQL database**

MySQL is an open source relational database management system that runs as a server providing multi-user access to a number of databases. The SQL phrase stands for Structured Query Language. The MySQL development project has made its source code available under the terms of the GNU General Public License, as well as under a variety of proprietary agreements. MySQL is a popular choice of database for use in web applications, and is a central component of the widely used LAMP open source web application software stack. Free-software-open source projects that require a full-featured database management system often use MySQL.

The following steps shows the installation of MySQL plugin in Eclipse:

1. open the Data Source Explorer window from window – show view – data Source Explorer:



Figure Data source explorer window

2. Right click in Data Source Explorer windows, and open New Connection Profile window:



Figure new connection profile window

3. In New Connection Profile window, select desire type of database for adding, and access to New Driver Definition window by double clicking. Then, configure all the values according to chosen database:



Figure New driver definition window

4. Click finish to complete.

**Basic functions of login**

After setting up system frameworks and platforms, login in module will be the first priority to concern on, since realizing basic login module is very necessary for testing system frameworks configuration and integration, and I will explain the concept of SSH clearer by this practical instance. Login module services have two actors – normal user and administrator. Normal users can login and perform all the functions provided by the system to meet their demands, conversely, administrators perform their duties to manage system, they login the backstage of system to manage administration module.

Activity diagram of Login Account is illustrated by the following figure:



Figure Activity diagram of Login process

Description

Actors: Normal User and Administrator

Actors access to login page, and input valid user name and password. System will verify User name and password, if is correct, login successfully, otherwise, login failed.

**Database design**

The following figure shows design of user table in database. All Users fell mainly into two classes: normal users and administrators, presented by user state 1 and user state 2 respectively. I also add certain attributes (Skype\_ID, email, etc.) related to further design of book-borrowing and living library system into the table.

User table of database shows as below:



Figure User table of database

**Code Structure**

The system code structure belongs to three layers: Dao layer, Service layer and Action layer. Dao layer uses Hibernate to operate the underlying database; Action layer’s main job is controlling front web pages, passing parameters and calling Service layer to process business logic.

System code structure is showed as below:



Figure Code structure

Since Dao layer uses Hibernate, it is easy to generate entity classes through the database table structure. It is unnessary to require mapping files from Hibernate becase of supportive comments of Java. Similarly, Struts2 and Spring also use comments, in this way, programmer can simplify work of configurate files and easily manage configurations.

The following code shows user name and password will be introduced to Action of Structs after their submits.

|  |
| --- |
| @Action(value = "login", results = {@Result(name = "success",type = "redirect", location = "/admin/main.jsp"),  @Result(name = "failure", location = "/admin/login.jsp")})  **public** String doLogin() {  List<User> users = userService.login(user);  **int** ret = users.size();  **if**(ret > 0) {  **return** "success";  } **else** {  **return** "failure";  }  } |

Action layer calls service layer to process user login logic, then Action decides actions for login successful or failed. This is how Struts2 plays the role here. Service layer calls Dao layer to operate database. After verification of information passed, administrators will be able to access to management interface of system backstage.

After successful login, administrators management interface is showed as below:



Figure Administrator's home page

## 7.2 Version 1.1 – Basic Borrow

## 7.3 Version 1.2 – Ranking and Recommendation

## 7.4 Version 1.3 - Notification

## 7.5 Version 2.0 – Login with binary code

## 7.6 Version 2.1 – Publish to web

# 8 Testing

## 8.1 Functional Test

## 8.2 Usability Test

**Library Management System test description**

We use an approach of usability testing that involves testing a relatively small, representative group of users in order to produce reliable results, reduce testing costs, and reduce the amount of time spent conducting and analyzing test results. Industry studies confirm that carefully designed tests with a small number of test participants (4-6, typically) discover at least 80% of the usability problems revealed in formal tests with much larger numbers of test participants.

**Test format**

The complete test for each test participant involved the following activities:

Pre-test activities consisted of phone calls to qualify the test participants and completion of a pre-test questionnaire designed to confirm that the test participant met our user profile requirements.

Formal testing in a usability lab involved testing individual participants in a lab environment set up much like a dorm, classroom or library. Users completed real-life scenarios using Library Management System while we recorded their activities on video and observed them through a one-way mirror. The usability test room (where test participants worked) was furnished with three video cameras set up to tape test participants from various angles.

Walkthrough—To test our scenarios and the general “do-ability” of the test, we invited a sample test participant to complete the test scenarios in the lab while we logged the results. We used the results from our walkthrough test participant to confirm that the test scenarios were readily understandable and to review our timing assumptions. The walkthrough experience gave us a chance to revisit some awkward wording and revise our test time limits.

Pilot test—After refining the test scenarios and questionnaires, we conducted a pilot test under authentic test conditions to make sure our revisions had corrected all critical problems with the test.

Post-task and post-test activities consisted of short questionnaires administered between scenarios and a longer questionnaire and interview administered after the final scenario. The test team used the final interview as an opportunity to ask test participants about specific issues that arose during their individual tests.

Summary sessions conducted after each test allowed the evaluation team to quickly examine test results and categorize usability issues discovered in the test.

**Test times**

We tested Library Management System both on weekday and on weekends. We tested two users per 1-hour session.

**Test participant selections**

We decided to test two groups of users, novice users and advanced users. By testing novices, we were more likely to collect information about the intuitiveness of the application. By targeting advanced users, we could be confident of assembling a group of people capable of performing the more difficult tasks we were asked to test.

Novice Profile: We selected novice test participants who met our requirements of having basic computer experience, including keyboarding skills, Windows experience, and the ability to access and navigate a Web browser.

Advanced Profile: We selected advanced users who met the minimal requirements of the novice users, but who in addition had previous experience using other library management programs (except for this Library Management System). We limited this study to participants who had extensive Web experience (6 months +).

**Test problems**

Test participant selection problems

We originally recruited and qualified three novice test participants and three advanced participants, each group containing a mixture of ages and genders. However, during one evening testing session, Library Management System was unexpectedly taken down for maintenance. We had to excuse our sole male novice participant test participant and recruit another on short notice. The replacement participant subject was a 45+-year-old female with advanced user skills.

Because of this substitution, our final test sample was composed of four advanced participant users and only two novice users.

Wide variations in Library Management System response

We noticed a considerable difference in system responsiveness depending on the time of day that the tests took place. Library Management System was very slow on weekday evenings, but quite responsive on weekend mornings. This is important to note because it may help explain why there is such a wide divergence of opinion among the test participants concerning the "speediness" of Library Management System.

**Scenario and questionnaire design**

We created a set of scenarios designed to test the issues discussed previously. Each scenario was designed to require between 15-25 minutes to complete. We constructed the scenarios to be as real-world as possible, containing multiple related tasks (e.g. searching a book and then borrowing it).

The questionnaires administered after each scenario and after the complete tests were designed to collect some of the "qualitative" data omitted from the formal testing. The questionnaires quizzed test participants about their perceptions about Library Management System and how well they understood and liked the product.

**Scenario design**

We revised our test scenarios slightly because of some problems that occurred during testing. The final scenarios and tasks were as follows:

|  |
| --- |
| Scenario 1: Registering for Library Management System and Logging On (time limit: 10 minutes) |
| Scenario 2: Searching, sorting and borrowing books (time limit: 15 minutes)  Task A: Search a book by the title  Task B: Sort the results by the author  Task C: Click one book and borrow it |
| Advanced user scenario  Scenario 3: Search a book by the title, ISBN, author, press, published date (time limit: 15 minutes)  Task A (Discontinued because application wouldn't support a search for non-existing Library Management System books).  Task B: Sort the results by the title, author, press, published date  Task C: Borrow a book  Task D: Check the books’ comments |
| Scenario 4: Cancel borrowing and Leaving Library Management System (time limit: 10 minutes)  Task A: cancel the previous borrowing  Task B: Sign off from Library Management System. |

**Time limits**

We allotted 50 minutes for the test participants to complete all four scenarios.

When we originally designed the scenarios, we believed that because of their limited abilities and experience, novice test participants might not have enough time to attempt Scenario 3, which tests the advanced Library Management System tasks.

However, because our novice users were able to complete scenarios 1, 2, and 4 reasonably quickly (setting aside system-imposed delays), we decided to allow them to attempt the more advanced tasks. As a result, the test scenarios and time allotments are the same for the two groups of test participants.

**Test questionnaires and interview design**

We designed a series of questionnaires to qualify potential test participants and to collect subjective feedback from the test participants during and after testing. The Appendix contains the actual questionnaires.

Pre-test questionnaire

To qualify test participants, we asked a series of questions designed to collect demographic information and to assess their level of computer and Internet experience. We accepted for testing those test participants who met our minimum requirements for novice or advanced users.

Post-task questionnaires

After the test participants completed each scenario, we administered a post-task questionnaire. The questionnaire was designed to capture feedback about Library Management System tasks while the test participant's memory was fresh. The questionnaires asked test participants to rate the ease or difficulty of the tasks, describe whether Library Management System's terminology relative to the task was clear, and provide free-form comments concerning the tasks.

Post-test questionnaire

After the test participants completed the final scenario, we administered a questionnaire designed to capture their general opinions about Library Management System. The questionnaire asked test participants to rate their interest in having online library management, their impressions about Library Management System's speed and responsiveness, and their overall satisfaction with the product.

Post-test interview

After each of the test participants completed the post-test questionnaire, the test briefer (the evaluation team's liaison with the test participant) scanned the questionnaire and asked the test participant to explain some of the responses. As the need arose, the briefer occasionally presented the test participant with additional questions that the evaluation team compiled while observing the test.

**Usability criteria**

To categorize the test observations, we applied a usability test analysis model that categorizes product usability problems according to whether they fail to meet any of the following 102 criteria:

1. Concept: Does the product use effective metaphors? Is it intuitive?

2. Consistency: Does the product look and perform similarly through all parts of the application?

3. Content: Is the content accurate, appropriately complex, and provided in the right amount? 4. Feedback: Does the product provide appropriate feedback to the user?

5. Interaction Model: Are user responses and other system interactions handled according to established models?

6. Navigation: Is it easy to get where you want to go in the product?

7. Terminology: Is the interface's language easy to understand for the audience(s)?

8. User Assistance: Does the product supply an appropriate amount of user help (e.g., online help, how to get customer service, other instructions)?

9. User Preference: Does use of the product cause difficulty for individual users in other ways not covered in these categories (e.g., does it favor "mouse users" over "keystroke users"; is it perceived to be too slow)?

10. Quality Assurance: Is the product robust? Does it fail in ways that prevent users from performing tasks?

Our test results produced findings in most of these areas, which we rated using the rating scales discussed in the following section.

**Scope and severity ratings**

After identifying usability problems, we rated their scope and severity. Scope refers to how widespread the problem was throughout the product, and severity codes rate the seriousness of the problem. Scope Local problems consisted of problems that occurred only in a particular part restricted to a particular part of the application, while global problems indicated far-reaching design flaws that occurred with consistency throughout the product. In general, global problems tend to be critical to correct, because they affect usability of the entire application, have far-ranging effects, and tend to be critical to correct. However, some local problems are critical enough to hamper severely the users' ability to perform key tasks.

Severity

We used the following severity codes to classify the seriousness of the problems we discovered:

1 - Prevents completion of a task

2 - Causes significant delays in completing a task

3 - Causes minor usability problems, but users can complete the task

4 - Minor annoyance - does not significantly impact usability, but should be corrected if time allows

# 9 Conclusion

## 9.1 Technical Complexity

## 9.2 Innovation

## 9.3 Future Enhancements

# 10 Appendices

## 10.1 Reference Guide

## 10.2 Usability test questionnaire

Library Management System Usability Test Final Report

Pre-Test Questionnaire

Thank you for considering being a volunteer for our Usability Test. We will work to make sure the test environment is pleasant and fun for you, with a casual dinner being served. The results from our Usability Test will be used to help improve a computer software product’s ease of use.

Please answer the following questions. We will use your answers to determine if you will be a participant in our Usability Test.

The testing will take place on March 22 and March 29 from 6-8 p.m. The usability test will require 1 1/2 hours of your time.

Please place a check next to the dates on which you are available, if any. March 22 \_\_\_\_\_\_ March 29 \_\_\_\_\_\_ Either Date \_\_\_\_\_\_ Neither Date \_\_\_\_\_

Please disregard the rest of the questionnaire if you are not able to attend one of the dates. Thank you again for your consideration. Name:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Home Phone: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Work Phone: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Age: [ ] 15-20

[ ] 21-30 [ ] 31-40 [ ] 41-50 [ ] 51 or above

Sex: [ ] Male [ ] Female [ ] Right handed

[ ] Left handed

Please answer the following questions about your computer experience:

1. Do you use an IBM or compatible personal computer?

[ ] Yes [ ] No

If you answered “no,” please disregard the remaining parts of the questionnaire.

2. What kind(s) of programs have you worked with? Check all that apply.

[ ] Word Processing [ ] Spreadsheets [ ] Graphics [ ] Other(s) specify

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

3. How long have you been using personal computers?

[ ] 0-3 months [ ] 4-6 months [ ] 7-9 months [ ] 10-12 months [ ] More than 12 months

4. Have you ever used a Web browser? [ ] Yes [ ] No

If you answered “no,” please proceed to question 7.

5. Which Web browser have you used? Check all that apply. [ ] Microsoft Internet Explorer [ ] Netscape Navigator [ ] Other(s) specify

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

6. How long have you been browsing the Web? [ ] 0-3 months [ ] 4-6 months [ ] 7-9 months [ ] 10-12 months [ ] More than 12 months

7. Which Internet Service Provider(s) do you use? Check all that apply.

[ ] AOL [ ] Prodigy [ ] CompuServe [ ] Mindspring [ ] Other (specify)

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

[ ] I do not use/have an Internet Service Provider

8. Does your Internet Service Provider (ISP) OR your work/school location provide an email

program?

ISP

[ ] Yes [ ] No [ ] Not applicable—I have no ISP

Work/School [ ] Yes [ ] No [ ] Not applicable—I don’t use email from

work/school If you answered “no” or “not applicable” to BOTH of the categories in this question, please proceed to question 11.

9. Which email program does your Internet Service Provider OR your work/school location

provide?

ISP

Work, School

Microsoft Outlook Express [ ] [ ] Express [ ] [ ] Eudora

[ ] [ ] Other (specify) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ [ ] [ ] I do not know.

[ ] [ ]

10. How long have you been using your Internet Service Provider’s OR your work/school

location’s email program? (If you use multiple programs, indicate the time period corresponding to the program for which you have the MOST experience.)

[ ] 0-3 months [ ] 4-6 months [ ] 7-9 months [ ] 10-12 months [ ] More than 12 months

11. Do you use the World Wide Web for email?

[ ] Yes [ ] No

If answered “no,” please proceed to question 14.

12. Which World Wide Web email program(s) do you use? Check all that apply.

[ ] Yahoo! [ ] Library Management System

[ ] Netscape [ ] Other (specify)

13. How long have you been using your World Wide Web email program(s)?

[ ] 0-3 months [ ] 4-6 months [ ] 7-9 months [ ] 10-12 months [ ] More than 12 months

14. Where do you use email? Check all that apply.

[ ] From a personal home account [ ] From an account at work

[ ] From a public access terminal (library, Internet cafe, other) [ ] From school [ ] Other (specify)

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

15. What do you use email for? Check all that apply.

[ ] Work [ ] Personal [ ] Other (specify)

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

16. Do you know how to send attachments to someone via email? [ ] Yes

[ ] No

17. Do you know how to make files for the email you receive so similar emails can be grouped? [ ] Yes

[ ] No

18. Do you know how to create and send a simple email message? [ ] Yes

[ ] No

Thank you for completing our questionnaire. We greatly appreciate your consideration and time. We will be in contact with you if you are selected to participate in our Usability Test. Thank you!

Library Management System Usability Test Final Report

Appendix D: Post-test questionnaire

Practical Products administered this questionnaire after the test participants completed the final scenario.

We reviewed the results with the test participants in post-test interviews.

Library Management System Usability Test Final Report

Post-Test Questionnaire:

Thanks for completing the usability test. Please answer the following questions about your experience with Library Management System. We will use your answers to provide important feedback to Library Management System's marketing and development staff.

Library Management System allows you to send and receive mail independent of any email programs you maintain through your ISP or through work/school. Library Management System is accessed through the World Wide Web, and your mail is therefore not tracked through your ISP or work-provided email.

1. On the following scale, rate your need for / interest in having anonymous email capabilities:

No interest/need Low interest/need Don't feel strongly either way Moderate interest/need High interest/need

[ ] [ ] [ ] [ ] [ ]

2.

On the following scale, rate your impression of Library Management System's speed and responsiveness:

Very slow Moderately slow Neither fast nor slow Moderately fast Very fast

[ ] [ ] [ ] [ ] [ ]

3.

Will you use Library Management System in the future?

Never Rarely Sometimes Fairly frequently Very frequently

[ ] [ ] [ ] [ ] [ ]

4. On the following scale, rate how highly you would recommend Library Management System to your friends and

associates:

Would NOT Would recommend Don't feel strongly either way Would probably Would strongly recommend with reservations recommend recommend

[ ] [ ] [ ] [ ] [ ]

5. If you plan to use Library Management System at all in the future, please indicate how you might use it (Check all that apply):

[ ] While traveling for pleasure [ ] While traveling for business [ ] At work for business use [ ] At work for personal use [ ] At home

[ ] Not applicable--will not use

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6. What did you like MOST about Library Management System?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

8. What did you like LEAST about Library Management System?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

9. What would you change about Library Management System?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

10. Optional: Please add any other comments about Library Management System that might be useful in helping

Library Management System staff improve this email product:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Library Management System Usability Test Final Report