



Chemistry Laboratory Management System

**A dissertation submitted for the Degree of Master of
Information Technology**

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Declaration

The thesis is my original work and has not been submitted previously for a degree at this or any other university/institute.

To the best of my knowledge it does not contain any material published or written by another person, except as acknowledged in the text.

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Abstract

The Eastern University of Srilanka is one of the well-established government institutions in Srilanka. But the management of this chemistry laboratory is maintained by traditional register based system about 30 years. Computerized “Chemistry Laboratory Management System” will be better option to replace with the existing traditional manual system. It will be an intranet based system as it is limited among people who deal with chemistry laboratory. Computerized system will simplify the maintenance of the activities of the chemistry laboratory.

Chemistry laboratory of eastern university possess all the necessary facilities a laboratory should have. Though this laboratory boasts of its facilities it has several drawbacks such as with the existing traditional system maintaining the chemistry laboratory is a difficult task. Because all the activities and entries related to the laboratory are maintained with manual paper work which necessities consumptions of reams of paper and time. As all activities are recorded in paper it takes more time when practical details are recalled. Date of expiry and minimum required amount of chemicals are not maintained. Apart from this the laboratory does not maintain any monthly or annual chemical stock details, thereby leading to sudden cancellations of practical sessions, when these chemicals are out of stock. This situation is identified by me and I proposed to develop a computerized database system covering main functionalities with an option to allow future expansion in future. The computerized “Chemistry Laboratory Management System” will solve all the problems above. Any authorized user can easily manage and access the system.

The system is ameliorated using apache web server as the server environment, PHP as the development language and MYSQL as the database management system to provide a low cost efficient solution for the client. Supporting system is developed with PHP, CSS. In order to use the system efficiently smooth simple user interfaces and functionalities are used.

“Chemistry Laboratory Management System” provides accurate and up-to-date information regarding the remaining and consumed quantities of chemicals and other laboratory accessories. System generates detailed report (daily, monthly and annual) to the main administrator regarding practical and research sessions. System provides breakage details of a student and easy access of information regarding the chemicals available in the laboratory. The system facilitates stock management by providing a notification alert to the administrator and thereby enabling stock to be purchased in time.

I hope that this project is going to change their management of chemistry laboratory into a significant success level.

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List of Abbreviations

CAS- Chemical Abstracts Service

CSS – Cascading Style Sheet

ER diagram- Entity Relationship diagram

HoD – Head of the Department

HTML- Hypertext Text Markup Language

IE- Internet Explore

M.Sc.Ed – Master of Science in Science Education

MSDS - Material Safety Data Sheet

PHP – Hypertext Preprocessor

SMS – Short Message Service

UAT -User Acceptance Test

UI-User Interface

UML -Unified Modeling Language

URL- Uniform Resource Locator

WAMP - (W-Windows A-Apache M-MYSQLP-PHP)

Chapter-01 Introduction

1.1 Background

The Eastern University of Srilanka is one of the well-established government institutions in Srilanka. This has well equipped chemistry laboratory capable of accommodating 100 students at one time. Both the students from physical science and biological science will be able to select chemistry as one of their subjects. Most of the practicals are being conducted to the undergraduate students from 1st year to 3rd year who follow chemistry as one of their subjects and to the 4th year students who do special degree in chemistry. Apart from the above mentioned students from M.Sc.Ed, the students who do researches based on chemistry and occasionally school students too practice practicals in chemistry laboratory of eastern university Srilanka. Students, demonstrators, practical in charge (Senior lecturer), Lab assistants, technical officer, and laborers will take part while a practical session is being conducted at the chemistry laboratory. Among them technical officer of chemistry laboratory plays a key role. Because the technical officer is the one who is responsible to mobilize the required chemicals and equipments from the inventory and to prepare the chemical solution in appropriate measurements based on number of students. Further he does the job of claiming the breakages which sometimes happens during practical session. He also place the orders for the needed chemicals and equipments and receive them once they arrived at the main storage of eastern university of Srilanka. Later he incorporates them into the laboratory inventory. Therefore the technical officer must work efficiently with responsibilities. Head of the department too has an important place in chemistry laboratory management, who is the one authorizes the purchase orders placed by technical officer and monitors the amount of chemicals consumed in practicals.

Computerized “Chemistry Laboratory Management System” will be better option to replace with the existing traditional manual system. It will be an intranet based system as it is limited among people who deal with chemistry laboratory. Using the following computerized system will simplify the maintaining of the activities of chemistry laboratory.

1.2 Motivation

Chemistry laboratory of eastern university possess all the necessary facilities a laboratory requires. Though this laboratory boasts of its facilities it has several drawbacks. Some of them are follows.

With the existing traditional system maintaining the chemistry laboratory is a difficult task. Because all the activities and entries (Chemical stock amounts and glassware breakage details) related to the laboratory are maintained with manual paper work which necessitates consumptions of reams of paper and time. As all activities are recorded in paper it takes more time when practical details are recalled. Instead of that using this computerized system, a particular detail could be recalled within seconds. Date of expiry and minimum required amount of chemicals are not maintained. Apart from this the laboratory does not maintain any monthly or annual chemical stock details, thereby leading to sudden cancellations of practical sessions, when these chemicals are out of stock. No reports regarding the consumption of chemical and glassware breakages are maintained (during practicals). Thus the technical officers and Head of the Department are uncertain about the remaining amounts of these items. Glassware breakages are not maintained in periodical order, thereby the number of breakages that took place during a certain practical remain uncertain. But the computerized “Chemical Laboratory Management System” will solve all the problems above.

1.3 Aims and objective of the project

This intranet based management system is designed to provide information regarding the chemistry laboratory for any staff (Head of the department, Lecturer in charge, demonstrators and technical officers) within the chemistry department.

The following are the specific objectives of this project.

- ❖ Provide accurate and up-to-date information regarding the remaining and consumed quantities of chemicals and other laboratory accessories.
- ❖ Provide a detailed report (daily, monthly and annual) to the main administrator regarding practical and research sessions.
- ❖ Maintain and provide easy access of information regarding the chemicals available in the laboratory.
- ❖ Facilitate stock management by providing a notification alert to the administrator and thereby enabling stock to be purchased in time.
- ❖ Since breakages of laboratory items are readily updated into the system, the breakage details of students could be easily obtained while completing their no claim form.
- ❖ Enable effective communication among users.
- ❖ Eliminate or reduce unnecessary cost, paper work, and loss of data.

1.4 Scope of the project

1. Different types of administrators are employed to manage different tasks of the system.
 - a. The Head of the Department is given all power and authority over the whole system.
 - b. Limited access is provided to the technical officer to update the system such as updating chemical consumption and breakages of glass ware.
2. Properties, existing amounts, consumption amounts, date of expiry and the minimum required amount of chemicals will be incorporated into the system.
Similarly the existing number and breakages of labwares and other laboratory accessories will be included into the systems database.
3. A detailed report will be generated at the end of each practical including the following information such as consumed quantities of chemicals and any breakage of labwares.
4. A detailed monthly report will be generated at the end of every month.
5. A detailed annual report will be generated at the end of the year.
6. A notification will be programmed into the system to alert the administrator before a certain period of time of a given chemical's date of expiry.
7. A notification will be programmed into the system to alert the administrator once the quantity of a given chemical reaches its minimum required amount.
8. Since the laboratory harbours several chemicals in it, a search option will be programmed into the system, enabling users to easily locate a given chemical and its available quantity.
9. Since the information regarding labware breakages are updated into the system's database, the breakage details for a particular student could be generated from the system.

1.5 Structure of thesis

Introduction chapter provides a general introduction of the project. It includes some description of what the project is about, need for this project, scope, aims and objectives which are to be achieved, user and system requirements and the structure of the dissertation.

Second chapter describes essential background information, literature review, comparison and review of other two similar systems and the available technologies and tools to implement the system.

Chapter Analysis and Design includes a detailed description of the functional and nonfunctional requirements of the system. Also this describes the structure of the overall system with design methodologies such as use case diagrams, use cases, entity relationship diagrams.

Fourth chapter includes appropriate coding and implementation tools and techniques which are used developing the system are included.

Chapter five explains how developed system is tested against the user requirements which are gathered at the beginning. Actual data from the clients' environment is used. The chapter also includes aspects such as test plan, test cases, use of test automation tools and testing frameworks.

Final chapter summarizes the work, discusses its findings and contributions, points out limitations of the current work, and also outlines directions for future research.

Chapter-02: Background

2.1 Background

At the chemistry laboratory of the eastern university Srilanka around 150 practicals are conducted during an academic year. Since every batch contain, more than 100 students in it, practical sessions are to be carried out by dividing students into two or three groups depending on the students' number. As the chemical quantities, which depends on the number of practical groups needed to be prepared by the technical officer, increases the work load. The demonstrators of the department inform the respective practicals to the technical officer, who in turn prepares the chemical, which are involved in that practical. Demonstrators also explain to students about the hazards of certain toxic chemicals encountered in practicals. The lecturer in- charge of the practicals monitors the practical sessions and guides the demonstrators in their duties. Head of the department too has an important place in chemistry laboratory management, who is the one authorizes the purchase orders placed by technical officer, monitors the amount of chemicals consumed in practicals. As all activities are recorded in paper it takes more time when practical details are recalled. Date of expiry and minimum required amount of chemicals are not maintained. Apart from this the laboratory does not maintain any monthly or annual chemical stock details, thereby leading to sudden cancellations of practical sessions, when these chemicals are out of stock

2.2 Comparison and contrast of similar system

There are many inventory systems available in internet. Some of them are open source. But most of them issue license for their software. Comparisons was done to identify availability of similar solutions and to identify typical functionalities. Also, when developing a system it is more appropriate to investigate the prior work done by others. But the similar systems helped me to find the technical requirements and include additional value for the proposed system.

2.2.1 Similar systems.

Following systems are similar inventory systems

ChemInventory

ChemInventory[1] mainly focused on chemical inventory

Following features offered by ChemInventory

- Search the chemicals
- Request an Order
- Location (Where chemicals stored such as fridge, store room)

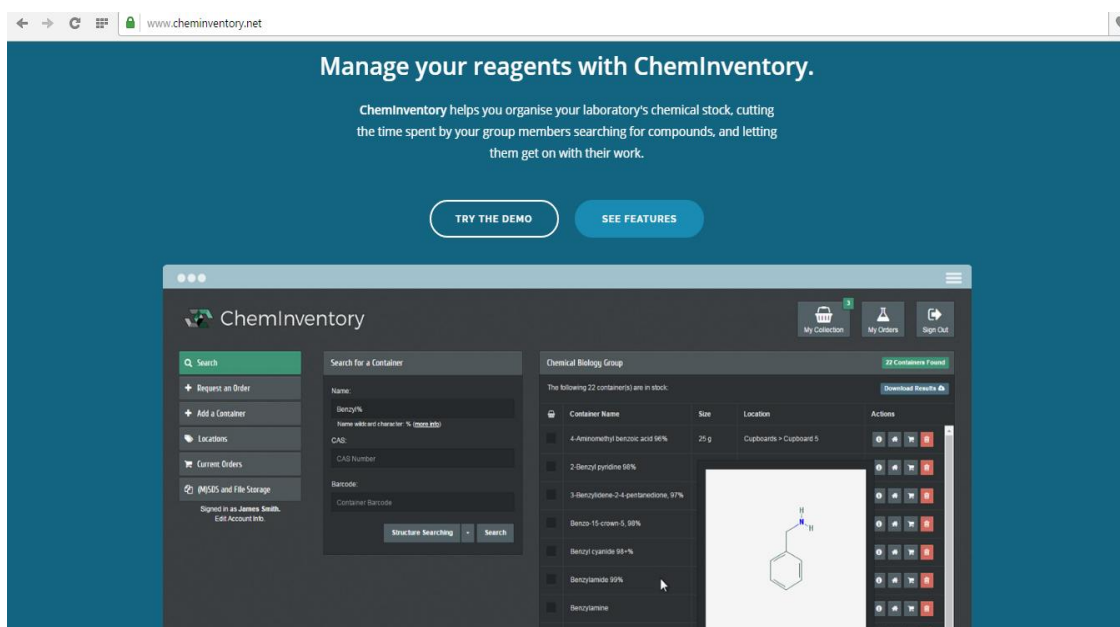


Figure 2.1 Index of ChemInventory

labUp

labUp[2] is designed by researchers for simplicity and complete automation of the laboratory, labUp is used not only for chemical inventory in the lab, but has modules for Safety Officers, compliance staff, waste disposal, purchase approval, and a whole lot more. labUp inventory is not only for chemical inventory, it is also focused for equipment inventory. Apart from the basic features of inventory, it offers advanced features such as share chemicals, ADR chemical waste disposal.

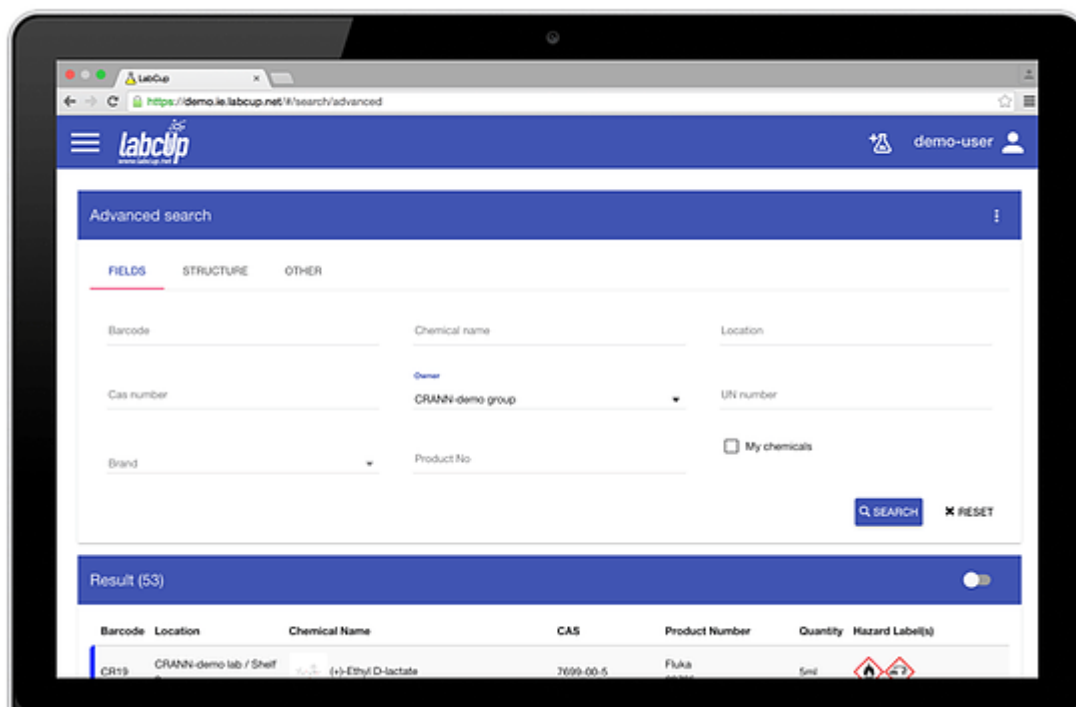


Figure 2.2: Index of labcup

EMS.inventory

Chemical Safety's EMS environmental health and safety software is a product with a rich history. It was the first commercially available chemical inventory tracking software solution offered in the United states market and it's since been widely adapted by corporations, universities, and government agencies. Today, EMS continues as a market leader [3].



Figure 2.3 EMS.Inventory

2.2.2 Comparison of proposed system with existing inventory system

Comparison with ChemInventory

ChemInventory is one of the chemical inventory management systems. It is mainly focused on the management of the chemicals. All the functions in the ChemInventory are completed related to the chemical inventory. But “chemistry laboratory management system” focuses on the chemical inventory, Equipment inventory, claim, practical and reports.

Functions like Search, Request an order, Add a container (chemical), locations, current orders, MSDS and file storage are the main functions offers by ChemInventory. Functions like search, locations, add a container which are present in “Chemistry Laboratory Management System” are analogs to the functions of ChemInventory.

In ChemInventory a chemical can be searched using its common name as done in proposed system. But in addition it provides advancements in search using barcode and CAS number. But there is no need for this advancement in search as far as chemical inventory of eastern university is concerned.

“Add a container” function in ChemInventory is related to the “Add chemical” function in Chemistry Laboratory Management System. Location such as cupboard, fridge and stores can be chosen when a user adds a container. Further more options like CAS number, barcode, supplier, product code are the other lacking in chemistry laboratory management system.

Table 2.1 describes comparison of proposed system with ChemInventory (Comparison made for chemical inventory only)

Table 2.1 comparison of proposed system with ChemInventory

Features	Chemistry Laboratory Management System	ChemInventory
Add a chemical with its properties	Yes	Yes
Update a chemical	Yes	Yes
Delete a chemical	Yes	Yes
Place an order	No	Yes
Alert when chemical reaches minimum required amount	Yes	No
Alert when chemical reaches expiry date	Yes	No
Generate reports	Yes	No
Hazard Details	Yes	Yes

Comparison with labcUp

labcUp inventory is not only for chemical inventory, it is also focused for equipment inventory [5] [6]. Apart from the basic features of inventory, it offers advanced features such as share chemicals, chemical waste disposal.

Table 2.2 describes comparison of proposed system with labcUp
(Comparison made for chemical inventory and equipment inventory)

Table 2.2 comparison of proposed system with labcUp

Features	Chemistry Laboratory Management System	labcUp
Add a chemical with its properties	Yes	Yes
Update a chemical	Yes	Yes
Delete a chemical	Yes	Yes
Place an order	No	Yes
Share chemical	No	Yes
Waste disposal	No	Yes
Alert when chemical reaches minimum required amount	Yes	No
Alert when chemical reaches expiry date	Yes	No
Generate reports	Yes	Yes
Hazard Details	Yes	No
Add equipment	Yes	Yes
Update equipment	Yes	Yes
Delete equipment	Yes	Yes

Comparison with EMS.inventory

Compared to EMS.Inventory, basic features of chemical inventory and equipment inventory are same as chemistry laboratory management system. But EMS inventory offers very advanced features which are listed below [4].

- ❖ Chemical storage incompatibilities management
- ❖ Android and mobile applications
- ❖ Green chemical alternatives
- ❖ Easy to use cloud-based web application
- ❖ Track chemicals from purchase through disposal
- ❖ No need to re-enter hazardous waste items
- ❖ Preconfigured federal and state reports
- ❖ Streamlined purchasing and approval processes

Chapter-03: Analysis and Design

3.1 Introduction

Analysis is mainly focused on requirement gathering, fact finding and find the functional-nonfunctional requirements of the system. At the same time brief analysis of existing chemical laboratory systems (manual system) also discussed. Once analysis completed successfully, can move to the design phase.

Software design phase is an iterative process in which requirements gathered in analysis are translated into a “blueprint” for constructing the system. At first, the blueprint depicts a high level abstract view of the system. Afterwards this can be elaborated into detailed functional and non-functional requirements.

3.2 Stakeholders of proposed system

Stakeholders are the most important persons to involve in the requirement analysis process. They are the persons who show interest about the system. Identified stakeholders of the system are;

- ❖ Head of the Department
- ❖ Technical Officer
- ❖ Lecturer in charge
- ❖ Demonstrators

3.3 Requirement analysis technologies

Gathering requirements is an essential activity in any kind of system developing. Since it is the most difficult, considerable amount of time has to be spent here. It is important to take wise decisions to make the analysis phase a success. Most commonly identifying the problem and what the client needed as the solution seems to be unclear at the beginning. Yet, when going forward it will come across to a clear situation.

Software developers should endeavor to understand the specifications of the software that they are currently working on or they are going to develop in the future. It is very important that they completely understand the requirements given by the client to reach the expected results. I took more time to gather requirements for my system. Because exist system in chemistry laboratory of eastern university is a manual system. I analyzed all the documents and reports according to the existing system to gather requirements. Some of the details missed from the documents because of lots of paper works. Then I got those details from technical officers. During the requirements collection, I found out that in certain unavailable circumstances expired chemicals are also being used for practical sessions. Furthermore I

found out that chemical irrelevant to practical are also formed lying in the chemical store without being used until now. Following techniques have been used for gathering requirements.

❖ Interviews

Interview is one of the easy ways to find users' reactions within limited time for this project. It is possible to carry out unstructured interviews and structured interviews according to the situations.

Unstructured Interviews: Only a general goal or subject in mind. Questions may vary from one individual to the other.

Structured Interviews: Pre-defined specific set of questions are there to ask from the interviewee.

I interviewed all the stakeholders individually. Technical officer gave most of the details to me. Because the most important primary user of my system is technical officer. The other stakeholders such as Head of the department, demonstrators, lecturer in charge gave good ideas of how the current system works and what are the points and functionalities that are missing from the current system.

❖ Documents Analysis

Reviewing documentation of the existing manual system was very important to understand the row data of the system. Also those were very useful to identify attributes to store the records in the data base.

❖ Questionnaires

Questionnaires are much more informal, and they are good tools to gather requirements from stakeholders in remote locations or those who will have only minor input into the overall requirements [7].

❖ Studying similar systems and observation

There are many inventory systems available in internet. Some of them are open sources. But most of them are issue license for their software. Comparison and contrast were done to identify availability of similar solutions and to identify typical functionalities. Also, when developing a system it is more appropriate to investigate the prior work done by others. But the similar systems helped me to find the technical requirements and include additional value for the proposed system.

3.4 Requirement analysis and Management

The gathered requirements should be analyzed and need to check for ambiguities to be solved. Requirements should be clear cut or it will leads to a problematic stage later. Requirement management is the process of managing the changes to the scope of the project according to the schedule and effort. Accepting new requirements from the client unconditionally will affect the project quality or it will lead to project delays. Therefore requirement management is also a critical task.

3.5 Analysis of the current system

The chemistry laboratory maintenance with the existing traditional system is a difficult task. Because all the activities and entries (Chemical stock amounts and glassware breakage details) related to the laboratory are maintained with manual paper work which necessities consumptions of reams of paper and time. As all activities are recorded in paper it takes more time when practical details are recalled.

3.6 Requirements for the new system

3.6.1 Functional requirements

❖ Functional requirements of Technical Officer

- Able to update his profile
- Able to add chemical details
- Able to update chemical details
- Able to delete particular chemical
- Able to search particular chemical
- Able to search particular equipment
- Able to add equipment details
- Able to update equipment details
- Able to delete particular chemical
- Able to view reports
- Able to print reports
- Able to enter practical details
- Able to enter claim details
- Able to search claim details
- Able to view particular equipment details
- Able to view chemical details

❖ Functional requirements of Head of the Department

Head of the department can access all the functions of “Chemistry Laboratory Management System”, because he is the responsible person for all the activities of chemistry department including chemistry laboratory. Technical officer is going to manage the chemical inventory (update chemical, delete chemical), equipment inventory (update equipment, delete equipment), claim management (add claim, delete claim) and practical entries. So I listed the important requirements of HoD below, but that doesn't mean he has the limited access (HoD can access all the functions).

- Able to manage users
- Able to update his profile
- Able to view reports
- Able to print reports
- Able to search particular chemical
- Able to search particular equipment
- Able to view particular equipment details
- Able to view chemical details.
- Able to view claim details.

❖ Functional requirements of Lecturer in charge

- Able to register into the system
- Able to update profile details
- Able to search particular chemical
- Able to view chemical details
- Able to search particular equipment
- Able to view particular equipment details

❖ Functional requirements of demonstrators

- Able to register into the system
- Able to search particular chemical
- Able to view chemical details
- Able to search particular equipment
- Able to view equipment details
- Able to update profiles

3.6.2 Non Functional requirements

Non-functional requirement is a requirement that specifies criteria that can be used to judge the operation of a system, rather than specific behaviors.

The non-functional requirements of the Chemistry Laboratory Management System are

- ❖ User friendliness - The system should be user friendly because the one who use the system have less knowledge about computers and how to operate complicated software. Therefore, the navigations and functions should be as simple as possible for the operator.
- ❖ Timeliness - This system replaces the current manual based system because of the inefficiency and slowness of the current methods used. Therefore, this system should be fast enough to improve the tasks of the user and it should be more effective than the current manual based system.
- ❖ Accurate - Although the details this system is going to handle does not side in the most vulnerable criteria, it has to be accurate because some major decisions such as order new chemical because the particular chemical reached minimum required amount, delete (from system) and dispose the a particular chemical which expiry date is reached and generation of claim report are made. Therefore, this system should be accurate.
- ❖ Security - although it eliminates the threat of hacking from outside because of the system's environment which is Intranet, There is a slight chance for the data operator to change the data and manipulate the data for his favor. So, It should be somehow robust and hard to break in kind of system.

3.6.3 Hardware and software requirements

- ❖ Hardware requirements

Table 3.1 Hardware requirements

	Recommended Hardware
Processor	Intel 2GHz or higher
Ram	512 RAM/1GB or higher
Hard disk	10 GB or more hard disk
Internet connection	Broad band connection
Resolution	1024 X 768 minimum

❖ Software requirements

Table 3.2 software requirements

	Recommended Software
Operating System	Windows XP or later
Web Server	Apache 2.x for Windows
PHP	PHP 5.x version
Database	My SQL 5.x version
Web browsers	IE6 +, Mozilla Firefox 3 +, Google Chrome(recommended)

3.7 Design of the System

The design and implementation phase of this “Chemistry Laboratory Management System” system development will concern with the design of proposed system using unified modeling language (UML) and the translation of the design into the desired design specifications into source code. The primary goal of the implementation is to write the source code and also that conforms to the specifications. Basically in this research PHP, MySQL used back end and JavaScript, JQUERY, CSS, HTML were used to design a user friendly interfaces because they are the more appropriate and most preferable programming language used for designing web based applications. The designed ER diagrams, UMLs are listed as Figures in next chapter.

3.7.1 ER Diagram

In software engineering, an entity–relationship diagram is a graphical representation of entities and their relationships to each other, typically used in computing in regard to the organization of data within databases or information systems. An entity is a piece of data-an object or concept about which data is stored. Main components of ER models are entities and the relationships that can exist among them [8].

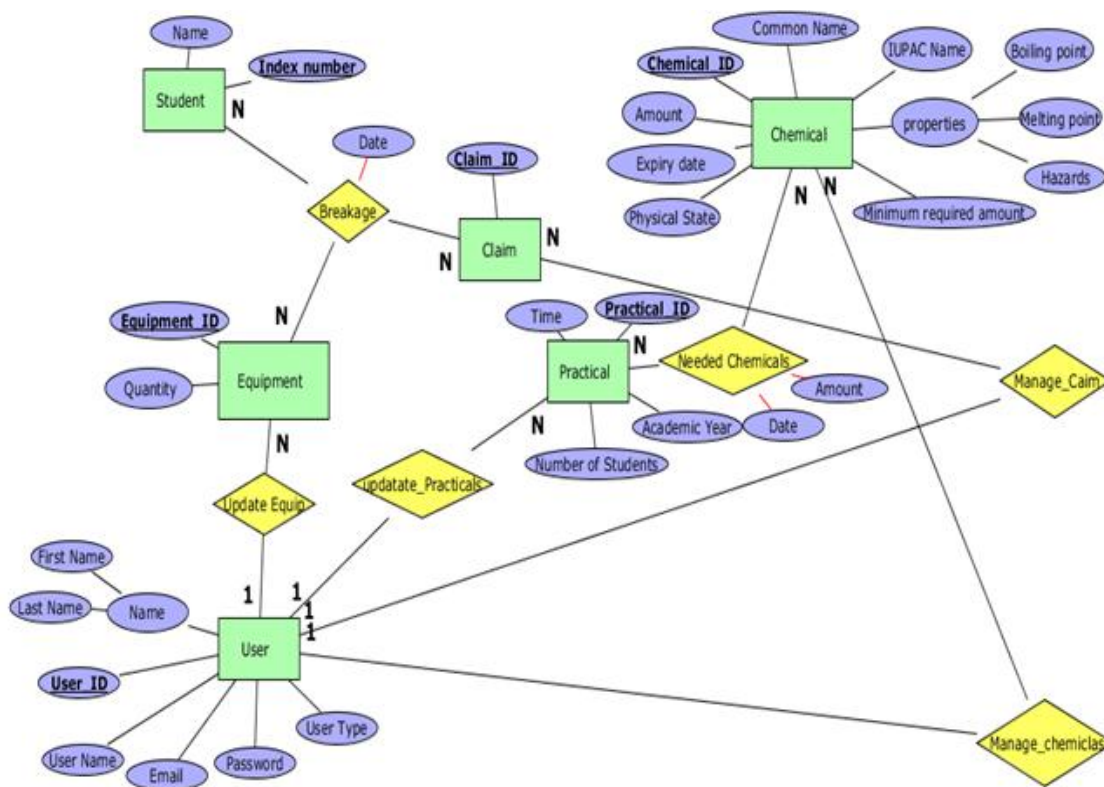


Figure 3.1 ER Diagram for developed system

3.7.2 Relational database model

User (User ID, user name, first name, last name Email, password, user type, contact number)

Student (Index Number, Name)

Equipment (Equipment ID, Amount, *User_ID*)

Practical (Practical ID, Time, Academic year, Number of students, *User_ID*)

Chemical (Chemical ID, Common Name, IUPAC Name, Boiling point, Melting point, Hazards, Minimum required amount, physical state, expiry Date, Amount, *User_ID*)

Needed Chemical (*Practical ID*, *Chemical ID*, date, Amount)

Claim (Claim ID, *User_ID*)

Breakage (*Claim ID*, *Equipment ID*, *Index Number*, Date)

Foreign keys are identified by italic format in my relational data model. Combined italic and underline format indicates that attribute can acts as primary key and also foreign key

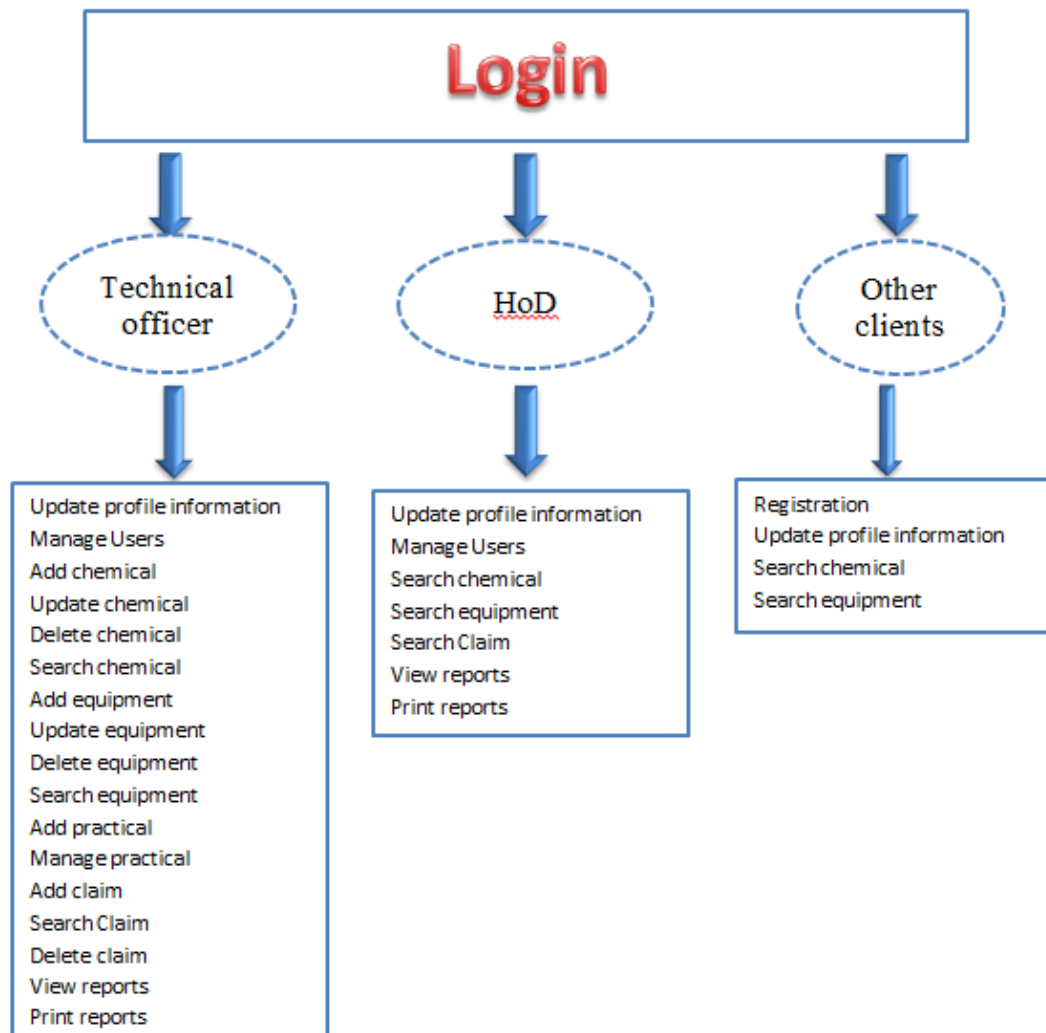


Figure 3.2 High level architecture diagram for proposed system

3.7.3 Use case diagram and description

Use case diagram offers a way to visualize a system's architectural blueprints in a diagram. UML shows the various activities users can perform in the system and represent the dynamic aspects of system also provides user's perspective of the system. In user case diagram an actors are users of the system and playing a particular roles [9].

❖ Use cases

When designing use case diagrams it was divided to four main categories for ease of drawing and understand ability. Use cases were drawn for each category and those are described below.

- Use cases related to Technical Officer
- Use cases related to Head of the Department

- Use cases related to Lecturer in charge
- Use cases related to Demonstrators
- ❖ Use cases related to Technical officer

Table-3.3: use case description for Login of technical officer

Use-Case Name	Login of technical officer
Use-Case ID	01
Primary business actor	Technical officer
Pre-Condition	Internet connection is important to access the system
Main flow	<ol style="list-style-type: none"> 1. Technical officer should visit the “Chemistry Laboratory Management System”. 2. System will ask User name and password. 3. Technical officer should give his/her User name and password 4. System does the authentication. 5. Admin Home page will display.
Alternative flow	<p>4 (a) Authorization Fails.</p> <p>4 (a) 1. A message will be displayed and that indicates “Incorrect User name or Password”.</p> <p>4 (a) 2. Technical officer will be allowed to re type User name and Password.</p>
Post-condition	Technical officer will access his functions.

Table-3.4: Use case description for Update profile of technical officer

Use-Case Name	Update profile of technical officer
Use-Case ID	02
Primary business actor	Technical officer
Pre-Condition	Internet connection is important to access the system. Technical officer should have logged in.
Main flow	<ol style="list-style-type: none"> 1. Technical officer should click “update profile” option. 2. Then Technical officer can update his/her profile 3. System does the authentication. 4. “New profile information” will be stored.
Alternative flow	
Post-condition	Technical officer can access the system with his new information.

Table-3.5: use case description for add new chemical details of technical officer

Use-Case Name	Add new chemical details
Use-Case ID	03
Primary business actor	Technical officer.
Pre-Condition	Internet connection is important to access the system. Technical officer should have logged in.
Main flow	<ol style="list-style-type: none"> 1. Technical officer should select the “chemicals” button which is appeared in his/her home page. 2. Then he/she should select the “Add chemical” button. 3. Then he/she should add new chemical details such as common name, IUPAC name, physical state, formula, boiling point or melting point, expiry date, minimum required amount. 4. Then he/she should click “add” button.
Alternative flow	-
Post-condition	-

Table-3.6: Use case description for update chemical details of technical officer

Use-Case Name	Update chemical details
Use-Case ID	04
Primary business actor	Technical officer.
Pre-Condition	Internet connection is important to access the system. Technical officer should have logged in.
Main flow	<ol style="list-style-type: none"> 1. Technical officer should select the “chemicals” button which is appeared in his/her home page. 2. Then whole chemicals will be appeared to the display, Technical officer should select the particular chemical or he/she can find it using “Search” option. 3. Then he/she can update the particular chemical details such as common name, IUPAC name, physical state, formula, boiling point or melting point, amount, expiry date, minimum required amount. 4. Then he/she should click “update” button.
Alternative flow	<p>2 (a) No chemicals were found on search.</p> <p>2 (a) 1. A message will be displayed “No chemicals found”</p> <p>2 (a) 2. Technical officer should retype the chemical name Correctly in the search option.</p> <p>2 (a) 3. Then he/she should click search button.</p>
Post-condition	-

Table-3.7: Use case description for Delete chemical details of technical officer

Use-Case Name	Delete chemical details
Use-Case ID	05
Primary business actor	Technical officer.
Pre-Condition	Internet connection is important to access the system. Technical officer should have logged in.
Main flow	<ol style="list-style-type: none"> 1. Technical officer should select the “chemicals” button which is appeared in his/her home page. 2. Then whole chemicals will be appeared to the display, Technical officer should select the particular chemical or he/she can find it using “Search” option. 3. Then he/she click delete button beside the particular chemical. 4. Then he/she should confirm the deletion.
Alternative flow	<p>2(a) No chemicals were found on search.</p> <p>2 (a) 1. A message will be displayed “No chemicals found”</p> <p>2 (a) 2. Technical officer should retype the chemical name Correctly in the search option.</p> <p>2 (a) 3. Then he/she should click search button.</p>
Post-condition	-

Table-3.8: use case description for Add new equipment details of technical officer

Use-Case Name	Add new equipment details
Use-Case ID	06
Primary business actor	Technical officer.
Pre-Condition	Internet connection is important to access the system. Technical officer should have logged in.
Main flow	<ol style="list-style-type: none"> 1. Technical officer should select the “Equipments” button which is appeared in his/her home page. 2. Then he/she should select the “Add equipment” button. 3. Then he/she should add new Equipment details such as name and amount. 4. Then he/she should click “add” button.
Alternative flow	-

Table-3.9: use case description for Update equipment details of technical officer

Use-Case Name	Update equipment details
Use-Case ID	07
Primary business actor	Technical officer.
Pre-Condition	Internet connection is important to access the system. Technical officer should have logged in.
Main flow	<ol style="list-style-type: none"> 1. Technical officer should select the “Equipments” button which is appeared in his/her home page. 2. Then whole equipments will be appeared to the display, Technical officer should select the particular equipment or he/she can find it using “Search” option. 3. Then he/she can update the particular equipment details such as name, amount, and type. 4. Then he/she should click “update” button.
Alternative flow	<p>2 (a) No equipments were found on search.</p> <p>2 (a) 1. A message will be displayed “No equipments found”</p> <p>2 (a) 2. Technical officer should retype the equipment name Correctly in the search option.</p> <p>2 (a) 3. Then he/she should click search button.</p>
Post-condition	-

Table-3.10: Use case description for Delete equipment details of technical office

Use-Case Name	Delete equipment details
Use-Case ID	08
Primary business actor	Technical officer.
Pre-Condition	Internet connection is important to access the system. Technical officer should have logged in.
Main flow	<ol style="list-style-type: none"> 1. Technical officer should select the “Equipments” button which is appeared in his/her home page. 2. Then whole equipments will be appeared to the display, Technical officer should select the particular equipment or he/she can find it using “Search” option. 3. Then he/she clicks delete button beside the particular equipment 4. Then he/she should confirm the deletion.
Alternative flow	<p>3 (a) No equipment were found on search.</p> <p>3 (a) 1. A message will be displayed “No equipment found”</p> <p>3 (a) 2. Technical officer should retype the equipment name Correctly in the search option.</p> <p>3 (a) 3. Then he/she should click search button.</p>
Post-condition	-

Table-3.11: Use case description for Search Chemical of technical officer

Use-Case Name	Search chemical.
Use-Case ID	09
Primary business actor	Technical officer.
Pre-Condition	Internet connection is important to access the system. Technical officer should have logged in.
Main flow	<ol style="list-style-type: none"> 1. Technical officer should select the “Chemicals” button which is appeared in his/her home page. 2. Then he/she should type the chemical name in search option box. 3. Then he/she should click search button.
Alternative flow	<p>3 (a) No chemicals were found on search.</p> <ol style="list-style-type: none"> 3 (a) 1. A message will be displayed “No chemicals found” 3 (a) 2. Technical officer should retype the chemical name Correctly in the search option. 3 (a) 3. Then he/she should click search button.
Post-condition	Technical officer can view and update the particular chemical details or he/she can delete the particular chemical.

Table-3.12: Use case description for Search equipment of Technical officer

Use-Case Name	Search Equipment.
Use-Case ID	10
Primary business actor	Technical officer.
Pre-Condition	Internet connection is important to access the system. Technical officer should have logged in.
Main flow	<ol style="list-style-type: none"> 1. Technical officer should select the “Equipments” button which is appeared in his/her home page. 2. Then he/she should type the equipment name in search option box. 3. Then he/she should click search button.
Alternative flow	<p>3 (a) No equipment were found on search.</p> <p>3 (a) 1. A message will be displayed “No equipment found”</p> <p>3 (a) 2. Technical officer should retype the equipment name Correctly in the search option.</p> <p>3 (a) 3. Then he/she should click search button.</p>
Post-condition	Technical officer can view and update the particular equipment details or he/she can delete the particular equipment.

Table-3.13: Use case description for View reports for Technical officer

Use-Case Name	View reports
Use-Case ID	11
Primary business actor	Technical officer
Pre-Condition	Internet connection is important to access the system. Technical officer should have logged in.
Main flow	<ol style="list-style-type: none"> 1. Technical officer should select the “Reports” button which appeared in his/her home page. 2. He/ She should select the report type (Monthly or annually). 3. Then he/she should select the particular month/ particular year. 4. The report will be displayed.
Alternative flow	-
Post-condition	-

Table-3.14: Use case description for Print Reports of technical officer

Use-Case Name	print reports
Use-Case ID	12
Primary business actor	Technical officer
Pre-Condition	Internet connection is important to access the system. Technical officer should have logged in.
Main flow	<ol style="list-style-type: none"> 1. Technical officer should select the “Reports” button which appeared in his/her home page. 2. He/ She should select the report type (Monthly or annually). 3. Then he/she should select the particular month/ particular year. 4. The report will be displayed. 5. Then he/she should click print button.

Table-3.15: Use case description for Enter practical details of technical officer

Use-Case Name	Enter practical details
Use-Case ID	13
Primary business actor	Technical officer
Pre-Condition	Internet connection is important to access the system. Technical officer should have logged in.
Main flow	<ol style="list-style-type: none"> 1. Technical officer should select the “Practicals” button which appeared in his/her home page. 2. The Practical session sheet will be appeared in his/her display. 3. He/she should fill/select the details such as date, practical code, practical number, consumed amount of chemicals. 4. Then he/she should select “Add Practical” button.
Alternative flow	-
Post-condition	-

Table-3.16: Use case description for Enter Claim of technical officer

Use-Case Name	Enter Claim for breakages.
Use-Case ID	14
Primary business actor	Technical officer
Pre-Condition	Internet connection is important to access the system. Technical officer should have logged in.
Main flow	<ol style="list-style-type: none"> 1. Technical officer should select the “Claims” button which appeared in his/her home page. 2. Then whole claim details will be appeared in his/her display. 3. Then he/she should click “Add claim” 4. Then add claim form will be displayed. 5. Then technical officer should fill the breakage details.
Alternative flow	-
Post-condition	-

Table-3.17: use case description for Search Claim of Technical officer

Use-Case Name	Search claim for breakages.
Use-Case ID	15
Primary business actor	Technical officer
Pre-Condition	Internet connection is important to access the system. Technical officer should have logged in.
Main flow	<ol style="list-style-type: none"> 1. Technical officer should select the “Claims” button which appeared in his/her home page. 2. Then whole claim sheet will be appeared in his/her display. 3. He/ She should search the particular student’s index number using search option.
Alternative flow	<p>3 (a) No Student were found on search.</p> <ol style="list-style-type: none"> 3 (a) 1. A message will be displayed “No student found” 3 (a) 2. Technical officer should retype the index number Correctly in the search option. 3 (a) 3. Then he/she should click search button.
Post-condition	<ol style="list-style-type: none"> 1. Then Claim form for particular student will be displayed.

- ❖ Use cases related to the Head of the department.

Table-3.18: Use case description for login of HoD

Use-Case Name	Login of HoD.
Use-Case ID	16
Primary business actor	HoD
Pre-Condition	Internet connection is important to access the system
Main flow	<ol style="list-style-type: none"> 1. HoD should visit the “Chemistry Laboratory Management System”. 2. System will ask User name and password. 3. HoD should give his/her User name and password 4. System does the authentication. 5. Home page of HoD will be displayed.
Alternative flow	<p>4 (a) Authorization Fails.</p> <p>4 (a) 1. A message will be displayed and that indicates “Incorrect User name or Password”.</p> <p>4 (a) 2. HoD will be allowed to re type User name and Password.</p>
Post-condition	HoD will access his functions.

Table-3.19: use case description for Update profile of HoD

Use-Case Name	Update profile of HoD
Use-Case ID	17
Primary business actor	HoD
Pre-Condition	Internet connection is important to access the system. HoD should have logged in.
Main flow	<ol style="list-style-type: none"> 1. HoD should click “update information” option. 2. Then HoD can update his/her profile 3. System does the authentication. 4. “New profile information” will be stored.
Alternative flow	-
Post-condition	HoD can access the system with his new information.

Table-3.20: Use case description for manage users of HoD

Use-Case Name	Manage users
Use-Case ID	18
Primary business actor	HoD
Pre-Condition	Internet connection is important to access the system. HoD should have logged in.
Main flow	<ol style="list-style-type: none"> 1. Technical officer should click “Manage users” option. 2. The details of users will be displayed 3. Then he/she can manage users
Alternative flow	
Post-condition	

Table-3.21: Use case description for Search Chemical of HoD

Use-Case Name	Search chemical.
Use-Case ID	19
Primary business actor	HoD
Pre-Condition	Internet connection is important to access the system. HoD should have logged in.
Main flow	<ol style="list-style-type: none"> 1. HoD should select the “Chemicals” button which is appeared in his/her home page. 2. Then he/she should type the chemical name in search option box. 3. Then he/she should click search button.
Alternative flow	<p>3 (a) No chemicals were found on search.</p> <ol style="list-style-type: none"> 3 (a) 1. A message will be displayed “No chemicals found” 3 (a) 2. HoD should retype the chemical name Correctly in the search option. 3 (a) 3. Then he/she should click search button.
Post-condition	HoD can access the particular chemical’s details.

Table-3.22: Use case description for Search Equipment of HoD

Use-Case Name	Search Equipment.
Use-Case ID	20
Primary business actor	HoD
Pre-Condition	Internet connection is important to access the system. HoD should have logged in.
Main flow	<ol style="list-style-type: none"> 1. HoD should select the “Equipments” button which is appeared in his/her home page. 2. Then he/she should type the equipment name in search option box. 3. Then he/she should click search button.
Alternative flow	<ol style="list-style-type: none"> 3 (a) No equipment were found on search. 3 (a) 1. A message will be displayed “No equipment found” 3 (a) 2. HoD should retype the equipment name Correctly in the search option. 3 (a) 3. Then he/she should click search button.
Post-condition	HoD can access particular equipment’s details

Table-3.23: Use case description for view reports of HoD

Use-Case Name	View reports
Use-Case ID	21
Primary business actor	HoD
Pre-Condition	Internet connection is important to access the system. HoD should have logged in.
Main flow	<ol style="list-style-type: none"> 1. HoD should select the “Reports” button which appeared in his/her home page. 2. He/ She should select the report type (Monthly or annually). 3. Then he/she should select the particular month/ particular year. 4. The report will be displayed.
Alternative flow	-
Post-condition	-

Table-3.24: Use case description for print reports of HoD

Use-Case Name	print reports
Use-Case ID	22
Primary business actor	HoD
Pre-Condition	Internet connection is important to access the system. HoD should have logged in.
Main flow	<ol style="list-style-type: none"> 1. HoD should select the “Reports” button which appeared in his/her home page. 2. He/ She should select the report type (Monthly or annually). 3. Then he/she should select the particular month/ particular year. 4. The report will be displayed. 5. Then he/she should click print button.
Alternative flow	-
Post-condition	-

Table-3.25: Use case description for search Claim of HoD

Use-Case Name	Search claim for breakages.
Use-Case ID	23
Primary business actor	HoD
Pre-Condition	Internet connection is important to access the system. HoD should have logged in.
Main flow	<ol style="list-style-type: none"> 4. HoD should select the “Claims” button which appeared in his/her home page. 5. Then whole claim sheet will be appeared in his/her display. 6. He/ She should search the particular student’s index number using search option.
Alternative flow	<p>3 (a) No Student were found on search.</p> <ol style="list-style-type: none"> 3 (a) 1. A message will be displayed “No student found” 3 (a) 2. HoD should retype the index number Correctly in the search option. 3 (a) 3. Then he/she should click search button.
Post-condition	Then Claim form for particular student will be displayed.

❖ Use cases related to Lecturer in charge.

Table-3.26: Use case description for Login of lecturer in charge

Use-Case Name	Login of Lecturer in charge.
Use-Case ID	24
Primary business actor	Lecturer in charge.
Pre-Condition	Internet connection is important to access the system
Main flow	<ol style="list-style-type: none"> 1. Lecturer in charge should visit the “Chemistry Laboratory Management System”. 2. System will ask User name and password. 3. Lecturer in charge should give his/her User name and password 4. System does the authentication. 5. Home page will display.
Alternative flow	<p>4 (a) Authorization Fails.</p> <p>4 (a) 1. A message will be displayed and that indicates “Incorrect User name or Password”.</p> <p>4 (a) 2. Lecturer in charge will be allowed to re type User name and Password.</p>
Post-condition	Lecturer in charge will access his functions.

Table-3.27: Use case description for Update profile of lecturer in charge

Use-Case Name	Update Profile of Lecturer in charge
Use-Case ID	25
Primary business actor	Lecturer in charge
Pre-Condition	<p>Internet connection is important to access the system.</p> <p>Lecturer in charge should have logged in.</p>
Main flow	<ol style="list-style-type: none"> 1. Lecturer in charge should click “update information” option. 2. Then Lecturer in charge can update his/her profile 3. System does the authentication. 4. “New profile information” will be stored.
Alternative flow	
Post-condition	Lecturer in charge access the system with his/her new profile information.

Table-3.28: Use case description for Search Chemical of lecturer in charge

Use-Case Name	Search chemical.
Use-Case ID	26
Primary business actor	Lecturer in charge
Pre-Condition	Internet connection is important to access the system. Lecturer in charge should have logged in.
Main flow	<ol style="list-style-type: none"> 1. Lecturer in charge should select the “Chemicals” button which is appeared in his/her home page. 2. Then he/she should type the chemical name in search option box. 3. Then he/she should click search button.
Alternative flow	<p>3 (a) No chemicals were found on search.</p> <p>3 (a) 1. A message will be displayed “No chemicals found”</p> <p>3 (a) 2. Lecturer in charge should retype the chemical name Correctly in the search option.</p> <p>3 (a) 3. Then he/she should click search button.</p>
Post-condition	Lecturer in charge can view the particular chemical’s details

Table-3.29: Use case description for Search Equipment of Lecturer in charge

Use-Case Name	Search Equipment.
Use-Case ID	27
Primary business actor	Lecturer in charge
Pre-Condition	Internet connection is important to access the system. Lecturer in charge should have logged in.
Main flow	<ol style="list-style-type: none"> 1. Lecturer in charge should select the “Equipments” button which is appeared in his/her home page. 2. Then he/she should type the equipment name in search option box. 3. Then he/she should click search button.
Alternative flow	<p>3 (a) No equipment were found on search.</p> <p>3 (a) 1. A message will be displayed “No equipment found”</p> <p>3 (a) 2. Lecturer in charge should retype the equipment name Correctly in the search option.</p> <p>3 (a) 3. Then he/she should click search button.</p>
Post-condition	Lecturer in charge can view particular equipment’s details

❖ Use cases related to Demonstrators.

Table-3.30: Use case description for Login of Demonstrator

Use-Case Name	Login of Demonstrator.
Use-Case ID	28
Primary business actor	Demonstrator.
Pre-Condition	Internet connection is important to access the system
Main flow	<ol style="list-style-type: none"> 1. Demonstrator should visit the “Chemistry Laboratory Management System”. 2. System will ask User name and password. 3. Demonstrator should give his/her User name and password 4. System does the authentication. 5. Home page will display.
Alternative flow	<p>4 (a) Authorization Fails.</p> <p>4 (a) 1. A message will be displayed and that indicates “Incorrect User name or Password”.</p> <p>4 (a) 2. Demonstrator will be allowed to re type User name and Password.</p>
Post-condition	Demonstrator will access his functions.

Table-3.31: Use case description for Update profile of Demonstrator

Use-Case Name	Update profile of Demonstrator
Use-Case ID	29
Primary business actor	Demonstrator
Pre-Condition	Internet connection is important to access the system. Demonstrator should have logged in.
Main flow	<ol style="list-style-type: none"> 1. Demonstrator should click “update information” option. 2. Then Demonstrator can update his/her profile 3. System does the authentication. 4. “New profile information” will be stored.
Alternative flow	
Post-condition	Demonstrator can access functions with his/her new information

Table-3.32: Use case description for Search Chemical of demonstrator

Use-Case Name	Search chemical.
Use-Case ID	30
Primary business actor	Demonstrator
Pre-Condition	Internet connection is important to access the system. Demonstrator should have logged in.
Main flow	<ol style="list-style-type: none"> 1. Demonstrator should select the “Chemicals” button which is appeared in his/her home page. 2. Then he/she should type the chemical name in search option box. 3. Then he/she should click search button.
Alternative flow	<p>3 (a) No chemicals were found on search.</p> <p>3 (a) 1. A message will be displayed “No chemicals found”</p> <p>3 (a) 2. Demonstrator should retype the chemical name Correctly in the search option.</p> <p>3 (a) 3. Then he/she should click search button.</p>
Post-condition	Demonstrator can view the particular chemical’s details

Table-3.33: Use case description for Search Equipment of demonstrator

Use-Case Name	Search Equipment.
Use-Case ID	31
Primary business actor	Demonstrator
Pre-Condition	Internet connection is important to access the system. Demonstrator should have logged in.
Main flow	<ol style="list-style-type: none"> 1. Demonstrator should select the “Equipments” button which is appeared in his/her home page. 2. Then he/she should type the equipment name in search option box. 3. Then he/she should click search button.
Alternative flow	<p>3 (a) No equipment were found on search.</p> <p>3 (a) 1. A message will be displayed “No equipment found”</p> <p>3 (a) 2. Demonstrator should retype the equipment name Correctly in the search option.</p> <p>3 (a) 3. Then he/she should click search button.</p>
Post-condition	Demonstrator can view particular equipment’s details

❖ Use case diagram

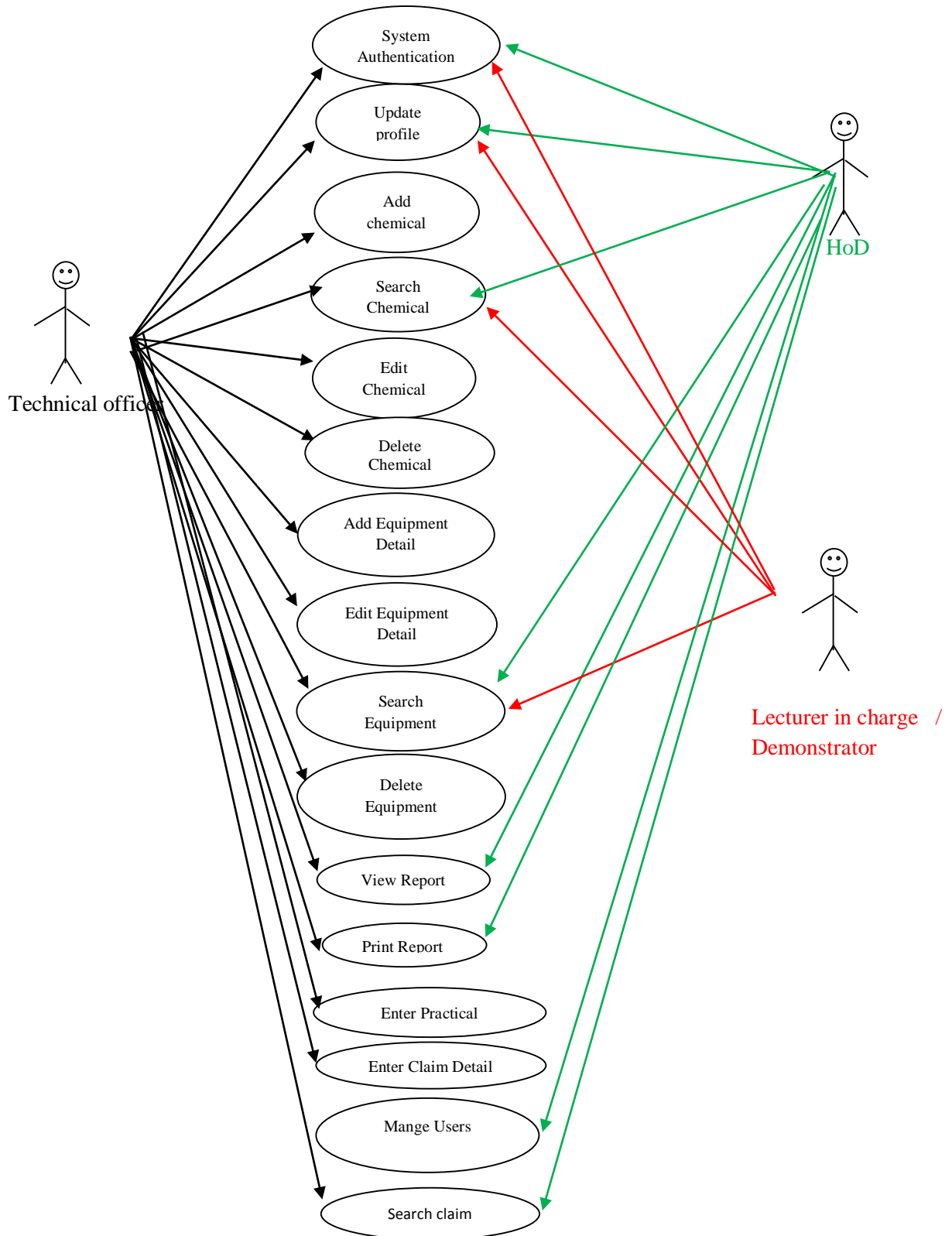


Figure 3.3 Use case diagram

3.7.4 Class diagram

A class diagram is a static structure diagram in UML and describes the types of objects in the system and the various kinds of static relationships that exist among them. Class diagrams are main building block of object oriented modeling. It is used both for general conceptual modeling of the systematic of the application, and for detailed modeling translating the models into programming code [10].

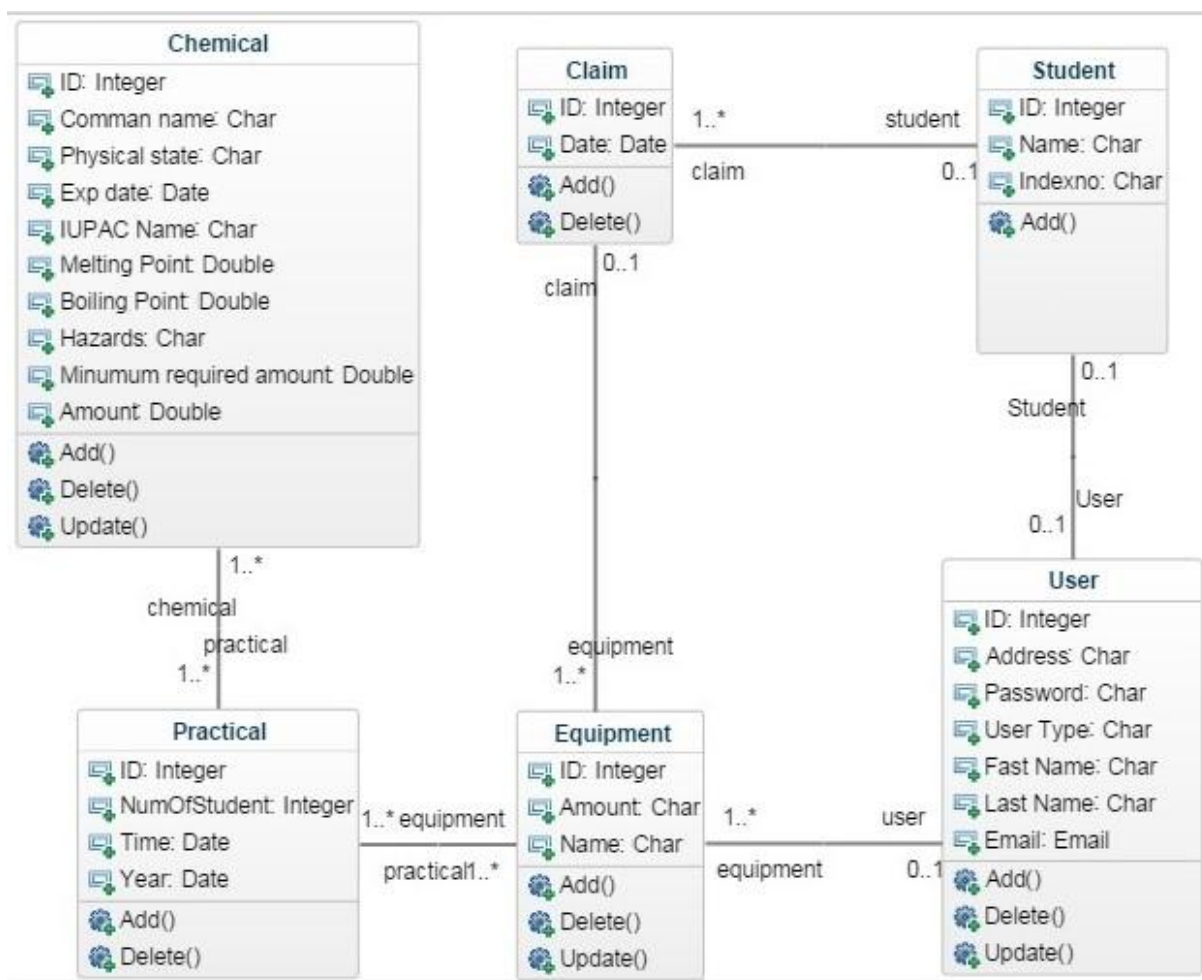


Figure 3.4 Class diagram

3.8 Summary

This chapter mainly focused on system analysis and design of the “Chemistry laboratory Management System”. Analysis chapter contain requirement gathering, requirement analysis and find the functional-nonfunctional requirements of the system at the same time brief analysis of existing inventory systems. Once analysis completed successfully can move to the design phase. It may focus on software architecture design and initial diagram designs such as ER diagram and UML diagrams. ER diagram, Class diagram, High level architecture diagram and use case diagrams are figure out in the above design section.

Chapter-04 Implementation

4.1 Introduction

The implementation phase of system development life cycle where an executable system which developed based on the design specified in the physical system specifications. And the output is source code of the system. Where the each components of the module implemented as a system module. Suitable and well known high-level language and appropriate tools were chosen to develop the source code. For the future modifications understandable comments also included to the source code.

Chemistry laboratory management system is a PHP based source files; implemented system with actual data. Those PHP based source files are used to develop computerized “chemistry laboratory management system” which contains all the requirements required by the clients (Staffs of chemistry laboratory eastern university Srilanka). All user interaction is performed remotely through the user's web browser. Users are categorized into two classes:

Administrators (HoD, Technical officer) and other clients (lecturer in charge, demonstrators). Administrators of running version of implemented chemistry laboratory management system have the responsibilities for Manage users, manage chemical (Add chemical, edit chemical, delete chemical), manage equipment (Add equipment, edit equipment, delete equipment) manage claim (Add claim, delete claim) and generating reports.

4.2 System Overview

“Chemistry Laboratory Management System” is an intranet based system. A new user (New demonstrators, new lecturers) should register to use the system. Administrators can access more functions than a regular users.

Chemical inventory and Equipment inventory are the most important parts of Chemistry Laboratory Management System. I added screen shots related those parts below. The brief system overview is given in user documentation (Appendices B).

Figure 4.1 shows the main page of chemical inventory. All chemicals can be seen with related property details. Update and delete options also given for each chemical. Search option is available in the main page of chemical inventory. So Administrator can search the particular chemical by its common name.

Chemistry Laboratory Management System

View listed Chemicals

Here You Can Search By Chemical's Common Name

Search Search

[Click Here to Add New Chemical](#)

Chemical_ID	Common Name	IUPAC Name	Formula	Physical State	Boiling/melting point	Hazzards	Expiry Date	Minimum Required Amount	Amount		
3	Hydrochloric Acid	hydrochloric acid	HCl	Solid	110	Corrosive	2017-04-06	500	5000	Update	Delete
4	Sodium hydroxide	sodium oxidanide	NaOH	Liquid	318	Corrosive	2017-03-25	450	10000	Update	Delete
5	Sulfuric acid	sulfuric acid	H2SO4	Liquid	335	Corrosive	2017-04-14	500	10000	Update	Delete
6	Nitric acid	nitric acid	HNO3	Liquid	83	Corrosive	2017-05-31	450	5000	Update	Delete
7	Potassium hydroxide	potassium hydroxide	KOH	Solid	360	Corrosive	2017-04-20	50	2000	Update	Delete

[Show All](#)

Figure 4.1 Main page of chemical inventory

Chemistry Laboratory Management System

View listed Chemicals

Here You Can Search By Chemical's Common Name

Search Search

[Click Here to Add New Chemical](#)

Chemical_ID	Common Name	IUPAC Name	Formula	Physical State	Boiling/melting point	Hazzards	Expiry Date	Minimum Required Amount	Amount		
6	Nitric acid	nitric acid	HNO3	Liquid	83	Corrosive	2017-05-31	450	5000	Update	Delete

[Show All](#)

Figure 4.2 Search chemical

Figure 4.2 shows the function of search option in chemical inventory. I searched “nitric acid” and the details of the nitric acid are displayed. So now user can update or delete the chemical.

Chemistry Laboratory Management System

Add New Chemical

Common Name :

IUPAC Name :

Formula :

Physical State :

Boiling/Melting Point :

Hazzards :

Expiry Date :

Minimum Required Amount :

Amount :

Figure 4.3 Add new Chemical

Figure 4.3 shows the Add chemical function. Administrator should click the “Click here to Add new chemical” link to add chemical (Which is in main page of chemical inventory). Then the administrator will be redirected to “Add chemical page”. Then he/she can add a new chemical into the system.

Update Chemical

Common Name :

IUPAC Name :

Formula :

Physical State :

Boiling/Melting Point :

Hazzards :

Expiry Date :

Minimum Required Amount :

Amount :




Figure 4.4 Update chemical

Figure 4.4 shows the Update a chemical function. Administrator should click the “update” link beside chemical. Then the administrator will be redirected to “update chemical page”. Then he/she can update chemical details.

Chemistry Laboratory Management System

View listed Equipments

Search Search

[Click Here To Add new Equipment](#)

EquipmentID	EquipmentName	Quantity		
7	clock class	199	Update	Delete
8	measuring cylinder	28	Update	Delete
9	Test tubes	100	Update	Delete

[Show All](#)

Figure 4.5 main page of equipment inventory

Figure 4.5 shows the main page of equipment inventory. All equipment can be seen with related quantity. Update and delete options also given for equipment. Search option is available in the main page of equipment inventory. So Administrator can search the particular equipment.

Chemistry Laboratory Management System

View listed Equipments

Search Search

[Click Here To Add new Equipment](#)

EquipmentID	EquipmentName	Quantity		
9	Test tubes	100	Update	Delete

[Show All](#)

Figure 4.6 Search equipment

Figure 4.6 shows the function of search option in equipment inventory. I searched “Test tubes” and the details of the test tubes are displayed. So now user can update or delete the equipment.

Chemistry Laboratory Management System

Add New Equipment



Equipment Name:

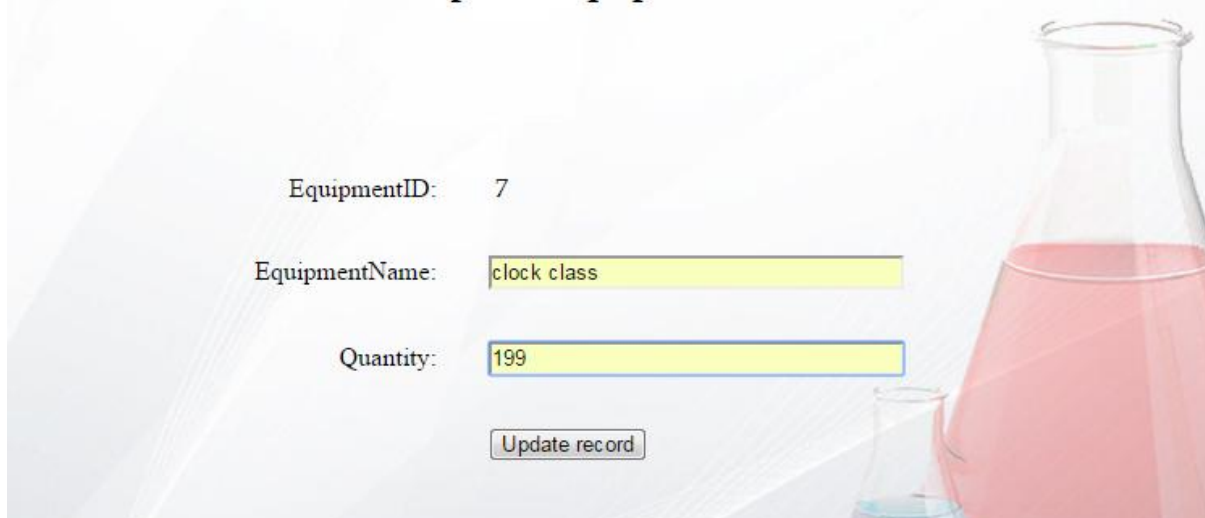
Quantity:

Figure 4.7: Add new equipment

Figure 4.7 shows the Add equipment function. Administrator should click the “Click here to Add new equipment” link to add equipment. Then the administrator will be redirected to “Add equipment page”. Then he/she can be add new equipment into the system.

Chemistry Laboratory Management System

Update Equipment



EquipmentID: 7

EquipmentName:

Quantity:

Figure 4.8: Update an equipment

Figure 4.8 shows the Update an equipment function. Administrator should click the “Click the update” link beside equipment. Then the administrator will be redirected to update equipment page”. Then he/she can update equipment.

4.3 Implemented tools and technologies

❖ Apache Web Server

Apache Server is the web server technology used in this Web application. It is the world most used web server software. It is played key role in the initial growth of World Wide Web. Apache is developed and maintaining by an open source community of developers. This sever software is available for various operating systems. According to Wikipedia, as of November 2015, Apache was estimated to serve 50% of all active websites and 37% of the top servers across all domains.

❖ PHP

PHP is a widely-used open source general-purpose scripting language that is especially suited for web development and can be embedded into HTML.

What distinguishes PHP from something like client-side JavaScript is that the code is executed on the server, generating HTML which is then sent to the client. The client would receive the results of running that script, but would not know what the underlying code was. You can even configure your web server to process all your HTML files with PHP, and then there's really no way that users can tell what you have up your sleeve. The best things in using PHP are that it is extremely simple for a newcomer, but offers many advanced features for a professional programmer [11]. PHP is a language that is specifically designed for web programming with built-in integration with the most popular open source database MySQL.

I used the PHP to implement my system because of the following features [12]

➤ Easy to start with:

As a beginner it is easy to start with PHP. The users just have to add a few PHP-tags with e.g. a for-loop in its existing HTML-files and then upload it to the server and see the result or an error message. Dynamic typing and associative arrays makes it also easier to start using PHP.

➤ Easy to use:

Compared to most solutions like e.g. Java, PHP doesn't need to be compiled, so it's just to write the script and then upload it to the server and then update the browser.

➤ Integrated database support:

PHP has (mostly) built-in support for the most popular databases like e.g. MySQL, that means it is easy to start using databases, no additional drivers needs to be installed, just to use the MySQL-functions. The easy to use web based admin tool PHP MyAdmin (released 1998) is also important to the PHP's success in combination with MySQL.

➤ Old language (since 1995) with a big user base:

PHP became popular early (1995) since it was designed for web programming. Since then the user base has grown and now there is many web-oriented frameworks and libraries available. Some examples are blog-systems and e-shopping-platforms.

➤ Cheap hosting:

Since PHP has existed for long time and works good on both Linux and Windows, and many webservers have support for it. There is no problem to find hosting with PHP pre-installed.

❖ MySQL Server

MySQL is a fast, easy-to-use RDBMS being used for many small and big businesses. MySQL is developed, marketed, and supported by MySQL AB, which is a Swedish company. MySQL is becoming so popular because of many good reasons:

- MySQL is released under an open-source license. So you have nothing to pay to use it.
- MySQL is a very powerful program in its own right. It handles a large subset of the functionality of the most expensive and powerful database packages.
- MySQL uses a standard form of the well-known SQL data language.
- MySQL works on many operating systems and with many languages including PHP, PERL, C, C++, JAVA, etc.
- MySQL works very quickly and works well even with large data sets.
- MySQL is very friendly to PHP, the most appreciated language for web development.

- MySQL supports large databases, up to 50 million rows or more in a table. The default file size limit for a table is 4GB, but you can increase this (if your operating system can handle it) to a theoretical limit of 8 million terabytes (TB).

MySQL is customizable. The open-source GPL license allows programmers to modify the MySQL software to fit their own specific environments [13].

- ❖ Notepad++

Notepad++ text editor used to do the coding. Its user friendly interface and short keys for do the coding helps to do this project faster.

- ❖ HTML 5

HTML is the mark-up language widely used for structuring content on a web browser. HTML 5 is the latest revision of HTML also it has so many new features and supports all modern browsers even IOS too. HTML5 widely support for multimedia and graphics.

- ❖ CSS 3

CSS3 is the latest revision of CSS family. It has so many new features like Drop shadows, rounded corners, Gradients, Transitions and etc. It reduces the time of coding and it supports various browsers and support java script, Java Query creates animations quickly.

4.4 Hardware and Software /Application Requirements

4.4.1 Hardware configuration

- ❖ Intel Core i3 Processor,
- ❖ 1 GB RAM
- ❖ 32-Bit/64-Bit Operating System
- ❖ 100 GB Hard Disk Drive
- ❖ Dual Monitors 1366 X 768

4.4.2 Software/Application configuration

- ❖ Apache Web Server 2.4.9
- ❖ PHP 5.5.12 and PHP My Admin support
- ❖ My SQL server 5.6.17
- ❖ Notepad ++ Text editor

4.5 Server environment

4.5.1 Hardware Configuration

- ❖ 3.0Ghz Intel Processor
- ❖ 1 GB RAM
- ❖ 100 GB Free Hard Disk Drive

4.5.2 Software/Application Configuration

- ❖ Apache Web Server 2.4.9
- ❖ PHP 5.5.12
- ❖ My SQL server 5.6.17

4.6 Client side requirement

4.6.1 Hardware Configuration

- ❖ Any Internet connected PC (at least of 512 KB/s speed internet) and having processor power more than 2.0 GHz.

4.6.2 Software/Application Configuration

- ❖ JavaScript enabled web browser

4.7 Summary

Implementation chapter focus on the “Chemistry Laboratory Management System” user interfaces as well as justification of technology, tools used in the system. Configuration of server, configuration of development pc, client hardware and software also mentioned briefly.

Chapter 5: Evaluation and Testing

5.1 Introduction

Testing is the process used to validate and verify the system. Testing is required in each phase of the software development. Always test plan required to test the entire system or components of system and identify the client requirements.

5.2 Objective of the Testing

1. To establish that the software worked satisfactorily as per the requirement of client.
2. To prove that the program is error free and user friendly with proper validations.
3. To certify that the software functioned correctly and could be used in production.

5.3 Front End Testing

Web based application mainly related with the web user interfaces (UI's). Black box testing methodology is used to check the UI's functions according to the test plan. System was tested in module wise and the test cases are listed below.

5.4 Browser Testing

Browser testing carried out for implemented Chemistry Laboratory Management System on all the latest browsers such as Chrome, Firefox, IE 10, Opera and Safari. As well as mobile friendly or responsive of the web pages also tested in browser level.

5.4.1 Browser Testing for Administrator Pages.

Table 5.1 Browser Testing for Administrator pages

Test Pages	Chrome	Firefox	IE 10	Opera	Safari
Login Page	√	√	√	√	√
Update Profile	√	√	√	√	√
Manage user	√	√	√	√	√
Add equipment	√	√	√	√	√
Edit equipment	√	√	√	√	√
Delete equipment	√	√	√	√	√
View equipment	√	√	√	√	√
Search equipment	√	√	√	√	√
Add chemical	√	√	√	√	√
Edit chemical	√	√	√	√	√
Delete chemical	√	√	√	√	√
View chemical	√	√	√	√	√
Search chemical	√	√	√	√	√
Add claim	√	√	√	√	√
View claim	√	√	√	√	√
Delete claim	√	√	√	√	√
Search claim	√	√	√	√	√
Practical details	√	√	√	√	√
View reports	√	√	√	√	√
Print reports	√	√	√	√	√

5.4.2 Browser Testing for Other clients' Pages.

Other clients of the chemistry laboratory systems are Lecturer in charge and demonstrators.

Table 5.2: Browser testing for other clients' Pages

Test Pages	Chrome	Firefox	IE 10	Opera	Safari
User registration	√	√	√	√	√
Login Page	√	√	√	√	√
Update Profile	√	√	√	√	√
View equipment	√	√	√	√	√
Search equipment	√	√	√	√	√
View chemical	√	√	√	√	√
Search chemical	√	√	√	√	√
Practical details	√	√	√	√	√

5.5 Test cases used to test login UI and function

User registration is the one of the important processes in chemistry laboratory management system. All Users other than administrators should enter a valid Email address and can register with the system. Various test cases had been used to test the procedure and a generalized test plan is shown below.

Table 5.3 Test cases used to test login UI and function

Test	Test Cases	Expected response From System	Success	Priority
1	New user input details with valid email address and details.	Add user details to the database and response registration success	Success	High
2	New user input details with invalid email address and details.	Form validation displays errors in relevant fields. System rejects input	Success	High
3	New user tries to register with blank details.	Form validation displays errors in relevant fields. System rejects input.	Success	High
4	Validate user password with confirm password field.	If both password and confirm passwords are similar user can proceed.	Success	High
5	User provides invalid username or password.	Notifies user that the user name or password is incorrect.	Success	High
6	User tries blank input and to login.	Notifies user that the user name or password is blank	Success	High
7	User click forgets password.	Provided input field to enter the email address of the user. Success	Success	High

Chemistry Laboratory Management System

Please Fill All the details to register

First Name: Krishnapillai
Last Name: Thevaruban
Email: <input type="text"/> A value is required.
User Name: KrishTheva
Password:
<input type="button" value="Register"/>

Figure 5.1: validation of user registration

Figure 5.1 shows the validation of user registration. Test plan ID 3 explains by the figure 5.1. When user tries to register with some blank details (Email address is blank), Form validation displays errors in relevant field. System rejects input.

5.6 Test cases used to test inventory related to chemical

Chemical inventory is the major part of the chemistry laboratory management system. Add new chemical, view all chemicals edit existing chemical details, delete chemical from system, search chemical, alert the administrator before a certain period of time of a given chemical's date of expiry and alert the administrator once the quantity of a given chemical reaches its minimum required amount are important processes related to the chemical inventory. All above processes can be accessed by administrator (HoD, Technical Officer). But other clients (Lecturer in charge, Demonstrators) can access some processes such as view all chemicals, search chemicals only. Various test cases had been used to test the procedure and a generalized test plan is shown below.

Table5.4 Test cases used to test inventory related to chemical

Test	Test Cases	Expected response From System	Success	Priority
1	User tries to add a new chemical with some blank details	Form validation displays errors in relevant fields. System rejects input.	Success	High
2	User tries to add a new chemical with valid details. (All fields are filled)	The new chemical will be added into the system and will be redirected to the display of all chemicals.	Success	High
3	User tries to add expiry date of a chemical which is less than system's current date	Form validation displays errors in expiry date field. System rejects input.	Success	Medium
4	User tries to update details of a chemical. (Clicks the update besides each chemical)	System will redirect the user to update page of particular chemical with all existing details are filled	Success	High
5	User tries to update the chemical details with some blank details.	Form validation displays errors in relevant fields. System rejects input.	Success	High
6	User tries to update expiry date of a chemical which is less than system's current date	Form validation displays errors in expiry date field. System rejects input.	Success	High
7	User tries to update the chemical details with valid details. (All fields are filled)	The new details to a particular chemical will be updated and system will redirect to the display of all chemicals.	Success	High
8	User tries to delete a chemical. (Clicks the delete besides each chemical)	System will ask the user that "are you sure to delete this chemical" (Alert)	Success	High

9	User tries to respond positive to the alert related to the deletion of a chemical. (If user clicks “Okay”)	Particular chemical will be deleted from the database.	Success	High
10	User tries to respond negative to the alert related to the deletion of a chemical. (If user clicks “Cancel”)	Particular chemical will not be deleted from the system.	Success	High
11	User tries to search a chemical with not filling the name (chemical name) in search box.	Search button will not respond (The page will be remained same as before)	Success	Medium
12	User tries to search for specific chemical by its common name	Particular chemical details will be shown in the display page.	Success	High
13	When quantity of a given chemical reaches its minimum required amount	System shows alert message	Success	High
14	When a chemical reached certain period (Normally one month) before its expiry date	System shows alert message. (Alert message reminds that the particular chemical is going to reach its expiry date soon)	Success	High

Chemistry Laboratory Management System

View listed Chemicals

Here You Can Search By Chemical's Common Name

Search

[Click Here to Add New Chemical](#)

Chemical_ID	Common Name	IUPAC Name	Formula	Physical State	Boiling/melting point	Hazzards	Expiry Date	Minimum Required Amount	Amount		
5	Sulfuric acid	sulfuric acid	H2SO4	Liquid	335	Corrosive	2017-04-14	500	10000	Update	Delete

[Show All](#)

Figure 5.2 Test plan for search chemical

Figure 5.2 shows the test plan for search chemical. Test plan 12 is explained by the figure 5.2. Here User tries to search for “sulfuric acid” and the details of sulfuric acid are displayed.

5.7 Test cases used to test inventory related to equipment

Equipment inventory is another major part of the chemistry laboratory management system. Equipment inventory connects with claim of students. Add new equipment, view all equipment edit existing equipment details, delete equipment from system, and search equipment. All above Processes can be accessed by administrator (HoD, Technical Officer). But other clients (Lecturer in charge, Demonstrators) can access some processes such as view all equipment, search equipment only. Various test cases had been used to test the procedure and a generalized test plan is shown below.

Table5.5 Test cases used to test inventory related to equipment

Test	Test Cases	Expected response From System	Success	Priority
1	User tries to add a new equipment with some blank details	Form validation displays errors in relevant fields. System rejects input.	Success	High
2	User tries to add new equipment with valid details. (All fields are filled)	The new equipment will be added into the system and will be redirected to the display of all equipment.	Success	High
3	User tries to update details of equipment. (Clicks the update besides each equipment)	System will redirect the user to update page of particular equipment with all existing details are filled.	Success	High
4	User tries to update the equipment details with some blank details.	Form validation displays errors in relevant fields. System rejects input.	Success	High
5	User tries to update the equipment details with valid details. (All fields are filled)	The new detail/details to particular equipment will be updated and system will redirect the user to the display of all equipment.	Success	High
6	User tries to delete an equipment. (Clicks the delete besides each equipment)	System will ask the user that “are you sure to delete this equipment” (Alert)	Success	High
7	User tries to respond positive to the alert related to the deletion of equipment. (If user clicks “Okay”)	Particular equipment will be deleted from the database.	Success	High
8	User tries to respond negative to the alert related to the deletion of equipment. (If user clicks “Cancel”)	Particular equipment will not be deleted from the system.	Success	High

9	User tries to search equipment with not filling the name (equipment name) in search box.	Search button will not respond (The page will be remained same as before)	Success	Medium
10	User tries to search for specific equipment.	Particular equipment details will be shown in the display page.	Success	High

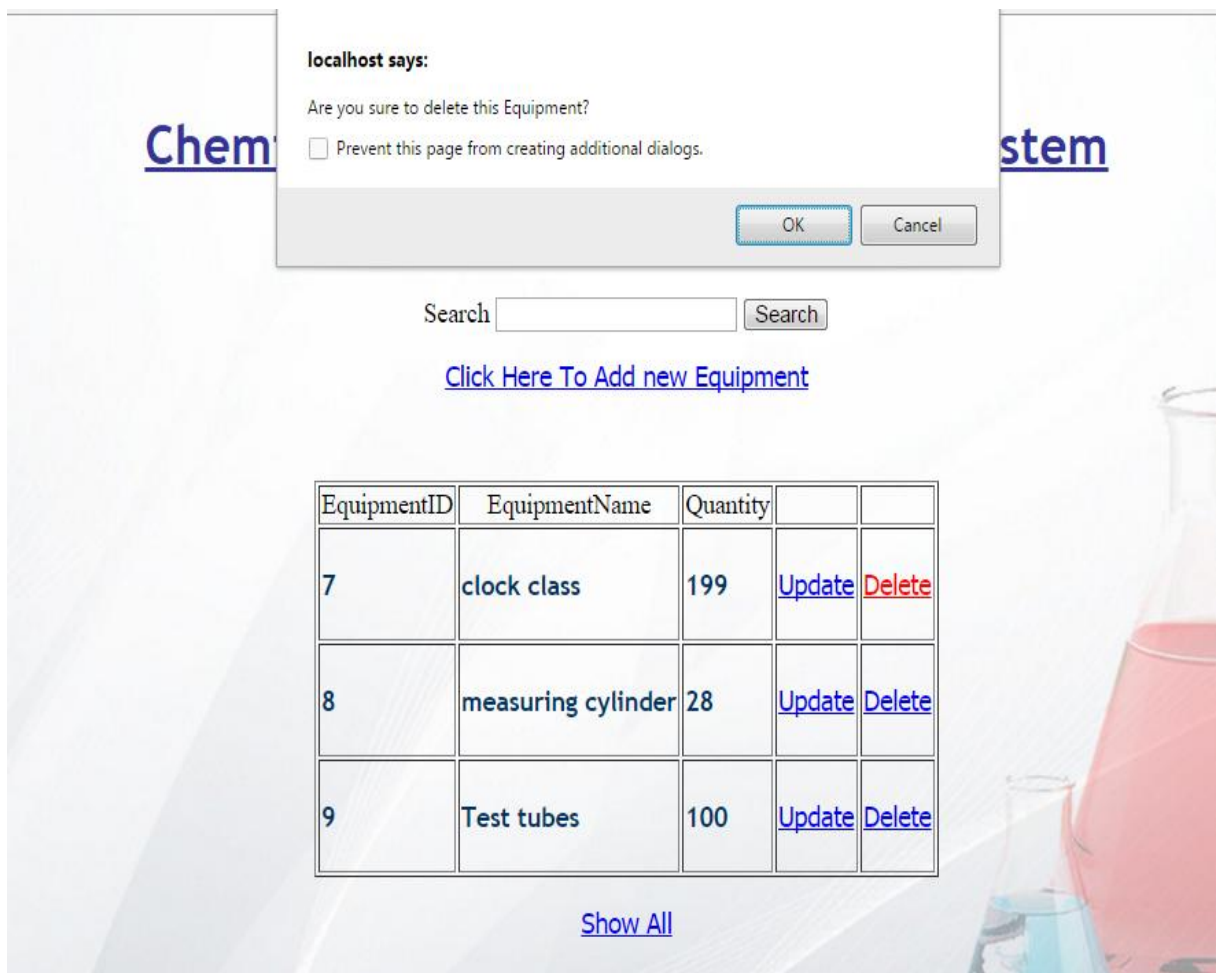


Figure 5.3 Alert on equipment deletion

Test case ID 6 is explained by the figure 5.3. Here administrator tries to delete the “clock class” by clicking the Delete link beside the clock class. Then the alert shows “Are you sure to delete this Equipment?”.

5.8 Test cases used to test students' claim

Students' claim will be used when a student breaks equipment. Administrators can only access all the processes of students' claim. Add claim, search claim and delete claims are the important processes of students' claim.

Table5.6: Test cases used to test related to student's claim

Test	Test Cases	Expected response From System	success	Priority
1	User tries to add a new claim with some blank details	Form validation displays errors in relevant fields. System rejects input.	Success	High
2	User tries to add new claim with valid details. (All fields are filled)	The new claim will be added into the system and will be redirected to the display of all claims.	Success	High
3	User tries to delete a claim. (Clicks the delete besides each claim)	System will ask the user that "are you sure to delete this claim report" (Alert)	Success	High
4	User tries to respond positive to the alert related to the deletion of claim. (If user clicks "Okay")	Particular claim will be deleted from the database.	Success	High
5	User tries to respond negative to the alert related to the deletion of claim. (If user clicks "Cancel")	Particular claim will not be deleted from the system.	Success	High
6	User tries to search claim with not filling the name (student's index number) in search box.	Search button will not respond (The page will be remained same as before)	Success	Medium

7	User tries to search for specific claim by using the particular student's index number (valid index number).	Particular student's claim details will be shown in the display page.	Success	High
---	--	---	---------	------

localhost says:
Are you sure to delete this claim?

OK Cancel

Search Claim by using student's index no:

Search Search

ClaimID	PracticalCode	ClaimDate	StudentName	IndexNo	EquipmentID	EquipmentName	Quantity	
24	CH251	2016-12-01	Thevaruban	BS932	8	measuring cylinder	7	Delete
26	CH253	2016-12-05	ramu	ps965	8	measuring cylinder	7	Delete
27	CH253	2017-03-01	Sajan	PS1356	9	Test tubes	2	Delete
29	CH153	2017-02-22	Rajasundram	PS1456	8	measuring cylinder	1	Delete

ost/chemistry/DeleteClaim.php?ClaimID=26

Figure 5.4 Alert on claim deletion

Chemistry Laboratory Management System

Search Claim by using student's index no:

Search Search

ClaimID	PracticalCode	ClaimDate	StudentName	IndexNo	EquipmentID	EquipmentName	Quantity	
24	CH251	2016-12-01	Thevaruban	BS932	8	measuring cylinder	7	Delete
27	CH253	2017-03-01	Sajan	PS1356	9	Test tubes	2	Delete
29	CH153	2017-02-22	Rajasundram	PS1456	8	measuring cylinder	1	Delete
30	CH351	2017-02-08	Thevaruban	BS932	9	Test tubes	2	Delete

Figure 5.5 confirm the deletion of a claim

Test plan 3 and 4 is explained by figure 5.4 and figure 5.5 respectively. Here figure 5.4 is shows that the administrator clicked the delete link beside the claim ID 26. Then there is an alert displayed with the message “Are you sure to delete this claim?”

The okay button was clicked (positive response to the deletion alert) the claim ID 26 and its details are completely deleted from the system (figure 5.5).

5.9 Test cases used to test practical entries and reports.

Each and every practical which occurs in chemistry laboratory should be included into the system. Consumed chemicals details of each practical will be added. Consumed chemicals details are connected with the amount in the chemical inventory. Practical entries will be summarized in report (monthly report, annual report). All the processes related to the practical entries and reports can be accessed only by administrators.

Table5.7: Test cases used to test related to Practical entries and reports

Test	Test Cases	Expected response From System	Success	Priority
1	User tries to add a new practical with some blank details	Form validation displays errors in relevant fields. System rejects input.	Success	High
2	User tries to add new practical with valid details. (All fields are filled)	The new claim will be added into the system and will be redirected to the display of all claims.	Success	High
3	User tries to delete a practical entry. (Clicks the delete besides each practical entry)	System will ask the user that “are you sure to delete this practical entry” (Alert)	Success	High
4	User tries to respond positive to the alert related to the deletion of practical entry. (If user clicks “Okay”)	Particular practical entry will be deleted from the database.	Success	High
5	User tries to respond negative to the alert related to the deletion of practical entry. (If user clicks “Cancel”)	Particular practical entry will not be deleted from the system.	Success	High
6	User tries to generate reports With valid date. (Date can’t be more than current date)	System will generate reports	Success	High
7	User tries to generate reports with invalid date	System will not generate reports and displays errors	Success	High
8	User tries to print the reports	Send print job to the printer	Success	Medium

5.10 User acceptance test

User acceptance test (UAT) is the one of the main evaluation/testing method before release the software. UAT get instance feedbacks from the end users and others who used this system previously. UAT results will forward to developer to fix the bugs. In short, they're executable specifications. Business rules, features and technical (non-functional) requirements can be captured as acceptance tests. This testing performed after functional and system testing, the product is delivered to a customer who runs black box acceptance tests.

Requirements of administrators and other clients are different (Administrators have more requirements than other clients). So I created two types of user acceptance forms which are user acceptance form for administrators (HoD, Technical officers) and user acceptance form for other clients (Lecturer in charge, demonstrators).

Printed user acceptance forms are distributed among the staffs of chemistry department of eastern university. Fifteen people participated and provided their feedbacks.

5.10.1 User acceptance test for administrators

User acceptance form for administrators is attached in appendices (*Figure B.11*)

Feedbacks of user acceptance form for administrators are listed below.

Table 5.8: Feedbacks of user acceptance form for administrators

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
Very poor	0	0	0	0	0	0	1	0	0
Poor	1	1	0	2	0	0	1	1	0
Good	1	1	1	1	1	2	7	1	3
Very good	8	9	10	8	9	10	5	7	8
Excellent	5	4	4	4	5	3	1	6	4

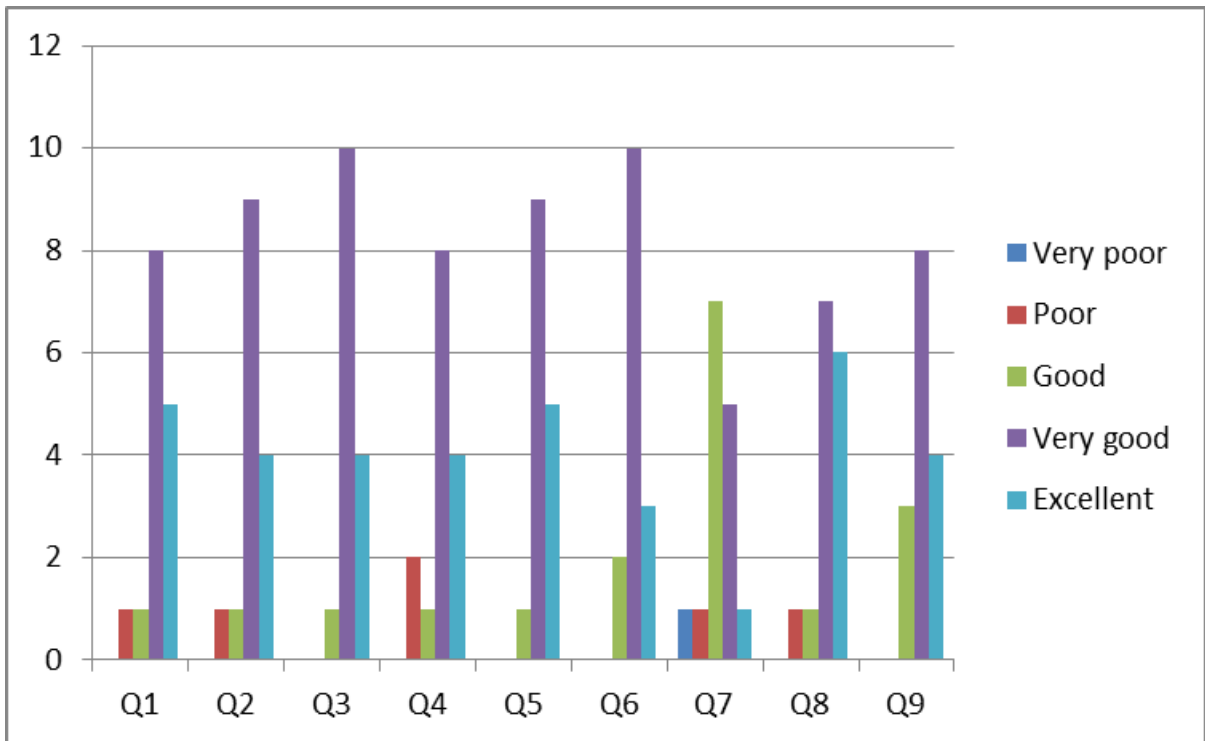


Figure 5.6: Result of user acceptance test (Administrator form)

With the result of user acceptance test chemistry laboratory management system mainly have to focus on the design of report generation of the system (Q7) because it getting poor rating other than all.

5.10.2 User acceptance test for other clients

User acceptance form for other clients is attached in appendices (*Figure B.12*)

Feedbacks of user acceptance form for other clients are listed below.

Table 5.9: Feedbacks of user acceptance form for other clients

	Q1	Q2	Q3	Q4	Q5
Very poor	0	0	0	0	0
Poor	1	0	0	2	0
Good	1	1	1	1	1
Very good	8	9	9	8	9
Excellent	5	5	5	4	5

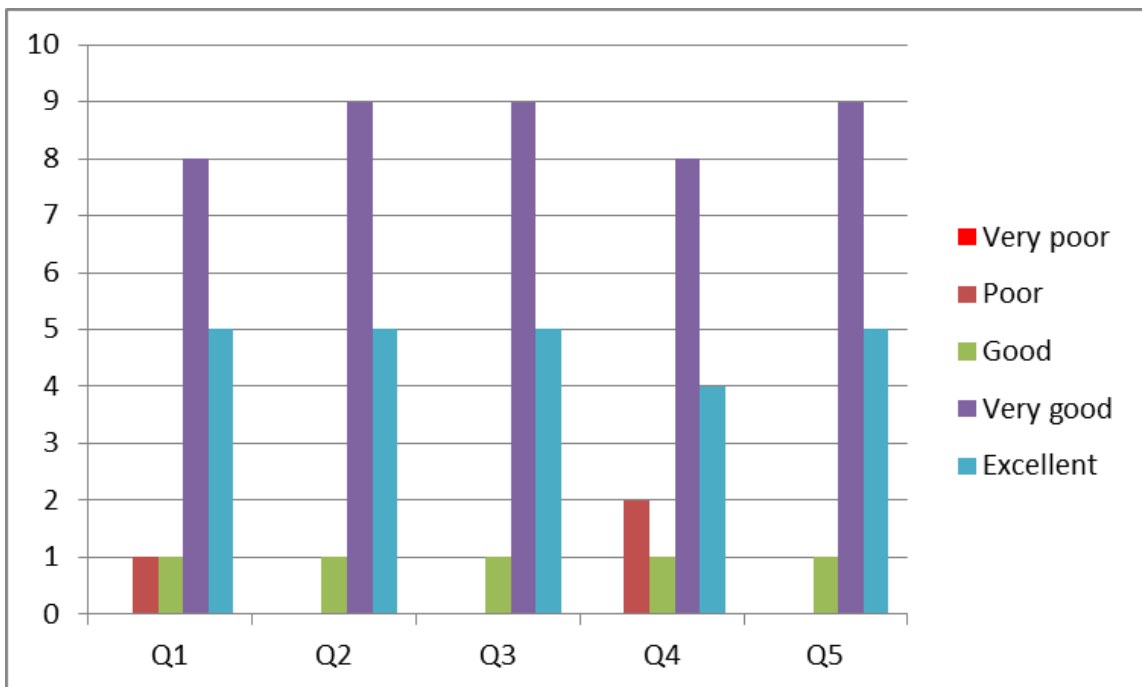


Figure 5.7: Result of user acceptance test (Other clients' form)

5.11 Identified strengths of the system

- ❖ Ease access and user friendly environment.
- ❖ Enable effective communication among users.
- ❖ Eliminate or reduce unnecessary cost, paper work, and loss of data.
- ❖ Provide accurate and up-to-date information regarding the remaining and consumed quantities of chemicals and other laboratory accessories.
- ❖ Maintain and provide easy access of information regarding the chemicals available in the laboratory.
- ❖ Facilitate stock management by providing a notification alert to the administrator and thereby enabling stock to be purchased in time.
- ❖ The breakage details of students could be easily obtained while completing their no claim form.
- ❖ Provide a detailed report to the main administrator regarding practical and research sessions.

5.12 Identified weakness of the system

- ❖ Developers may need some programming knowledge other than basic knowledge to develop further.
- ❖ Data backup functionality not available
- ❖ If administrator deletes the user or chemical or equipment or claim then he has to add them again.

Chapter 6: Conclusion and Future Work

6.1 Introduction

This chapter focused on concludes the dissertation with a critical evaluation of the system, lesson learned and suggestions for any future work.

Initially it was very hard to identify the system requirements because there was no proper management in the chemistry laboratory. The requirements were sought out by the help of the department head and other staff in the laboratory. Although, this system didn't have a sample system to look up to, it was easier to get a sketch of the problems faced with the registry based system and convert them into functionalities in the new system. The system was created with simple form based layout to make the user feel more comfortable with it and the functional and non-functional requirements were well thought out before creating the system. Simple system architecture was drawn out at first to get the idea of the functionalities and scope of this system and it was followed throughout the project to make the system more symmetric.

6.2 Lesson learnt

In the process of develop this system author required to gain knowledge in several aspects. Such as software development, software testing and write test cases, documentation. If simply say from requirement analysis stage to testing and distribution of the system a thorough knowledge needed to be acquired. The self-confidence to complete the project successfully on time has been a great achievement for me. Author had to learn the programming PHP, HTML, Java Script, MySQL and many other important technologies related to software development.

6.3 Achieved objects

Intranet based “Computer Laboratory Management System” is designed to provide information regarding the chemistry laboratory for anyone within the chemistry department. The following are the achieved objectives of this project.

- ❖ Provide accurate and up-to-date information regarding the remaining and consumed quantities of chemicals and other laboratory accessories.
- ❖ Provide a detailed report (daily, monthly and annual) to the main administrator regarding practical and research sessions.
- ❖ Maintain and provide easy access of information regarding the chemicals available in the laboratory.

- ❖ Facilitate stock management by providing a notification alert to the administrator and thereby enabling stock to be purchased in time.
- ❖ Since breakages of laboratory items are readily updated into the system, the breakage details of students could be easily obtained while completing their no claim form.
- ❖ Enable effective communication among users.
- ❖ Eliminate or reduce unnecessary cost, paper work, and loss of data.

6.4 The works could be extended

Students can be included into the system in future. Because students are also a part of the chemistry laboratory. Then some of the functional requirements should be develop when we incorporate them such as request to the administrator for claim details, and then view their claim details with permission of administrator.

Future work focus on which are the areas have to develop further and system should be rich intractable as well as much professional. Further some features can develop as follows.

- ❖ SMS alert to the administrator when a chemical reached its minimum required amount.
- ❖ SMS alert to the administrator when a chemical reached its expiry date.
- ❖ Admin level should have the ability to take backup of data.
- ❖ Admin must have the ability to suspend the user and reactivate without data loss.
- ❖ User interface can be improved to help the user work with the system easier and faster.

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Appendices

Appendices A: System Documentation

Title: Chemistry Laboratory Management System

Date: 08.03.2017

Version: 1.0

System: Intranet based system

This section of the documentation provides information for the system administrators, developers and who involve in the system to develop further. Those who would like get the technical information in order to configure and use the system successfully.

Table A.1: Hardware requirements

	Recommended Hardware
Processor	Intel 2GHz or higher
Ram	512 RAM/1GB or higher
Hard disk	10 GB or more hard disk
Internet connection	Broad band connection
Resolution	1024 X 768 minimum

Table A.2: Software requirements

	Recommended Software
Operating System	Windows XP or later
Web Server	Apache 2.x for Windows
PHP	PHP 5.x version
Database	My SQL 5.x version
Web browsers	IE6 +, Mozilla Firefox 3 +, Google Chrome(recommended)

Configuration of the pre required software

This section provides installation, compilation and execution details of the system.

Install WAMP server

WAMP stand for (W-Windows A-Apache M-MYSQLP-PHP). Using WAMP can configure web application locally with webserver, database together with PHP. Through

(<http://www.wampserver.com/en/>) can download WAMP server install file (.exe) freely.

The simplicity of configuration and the user friendliness of the WAMP (Windows, Apache, MySQL, PHP) server made the author get use of it as a whole without using the above software separately. Since it is open source, it will give an added advantage too.

On server side implementation a web server should be configured first, Apache server should be installed firstly. If the user is using an already deployed web server UNIX or Windows running Apache server configured with PHP 5 and MySQL 5, completing the system installation part is enough.

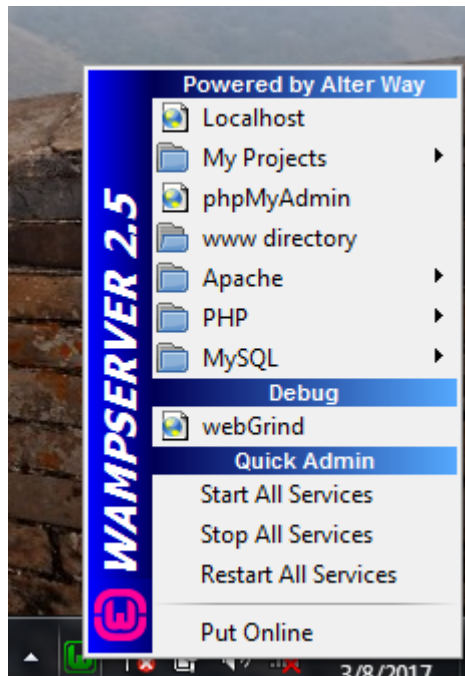


Figure A.1: Startup WAMP server

Once installed as (figure A.1) WAMP server will be present in local pc. Follow below steps:

The “www” directory will be created automatically usually in (c:\wamp\www)

Create a subdirectory name as “chemistry” in “www” and put your PHP files inside.

Start WAMP server by click on the “localhost” link in the WAMP Sever menu then open your internet browser and go to the URL : <http://localhost/chemistry>.

Below details required to upload in live server user want to provide it.

```
$hostname="localhost";  
$username="root";  
$password="";
```

Appendices B: User Documentation

User documentation provides the brief description about the system to the users. Users can be Administrators (HoD, Technical Officer), other clients (Lecturer in charge, Demonstrators). Pages of administrators and other clients are almost same. But most importantly Add, update and Delete options cannot be seen in normal clients' pages.

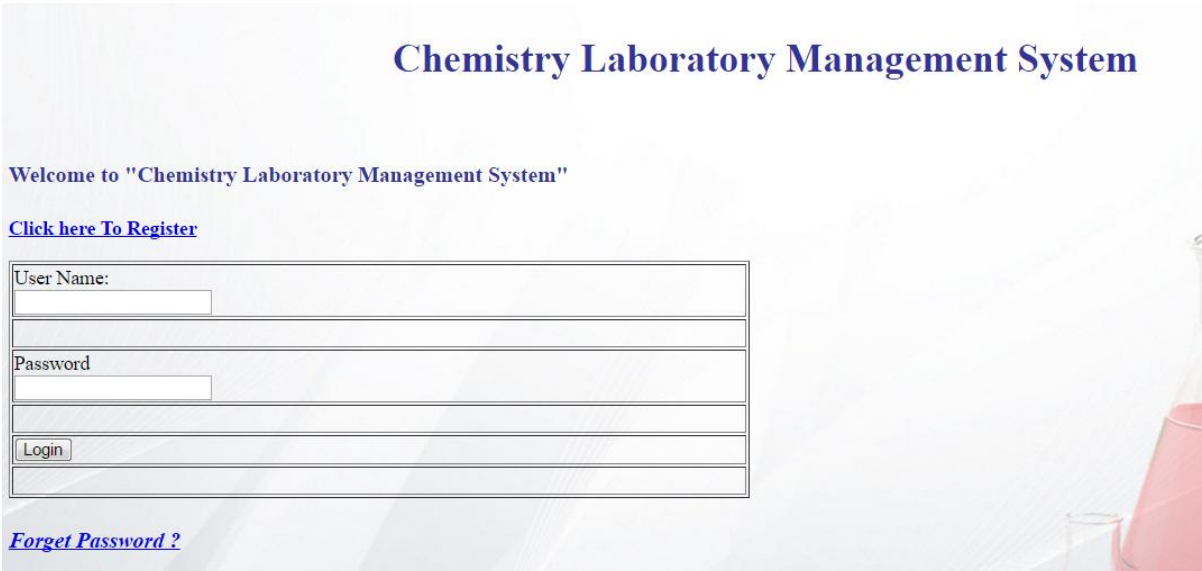
Index Page and Login

"Chemical Laboratory Management System" is an intranet based system. So Staffs of chemistry department can only access the system. Staffs should register to use the system.

"Click here to register" link which appears in index page should be chosen to register.

First name, Last name, Email, User name, Password should be given to register into the system (All details should be given).

After the registration, User can access the system.



Chemistry Laboratory Management System

Welcome to "Chemistry Laboratory Management System"

[Click here To Register](#)

User Name:
<input type="text"/>
<input type="text"/>
Password
<input type="text"/>
<input type="text"/>
<input type="button" value="Login"/>
<input type="text"/>

[Forget Password ?](#)

Figure B.1: Index Page of the system

Chemistry Laboratory Management System

Please Fill All the details to register

First Name: <input type="text"/>
Last Name: <input type="text"/>
Email: <input type="text"/>
User Name: <input type="text"/>
Password: <input type="text"/>
<input type="button" value="Register"/>
<input type="text"/>




Figure B.2: User registration page

Control panel Page

If a user successfully login into the system, then the control page of the particular user will be displayed. User can select chemical or equipment or Claim or practical or report. Update profile information also displayed in the control panel page. So user can update his/her profile.

Welcome to Chemistry Laboratory Management System

Control Panel



Chemicals

Click above to view listed chemicals.



Equipments

Click above to view listed Equipments



Claims

Click above to view and add new claims.



Practicals

Click here to view about Practical



Update Information

Click above to edit account information

Log Out

Figure B.3: Control panel Page of the system

Chemical inventory Page

If administrator clicks “chemical”, then main page of chemical will be displayed. All chemicals can be seen with related property details. Update and delete options also given for each chemical. Search option is available in the main page of chemical inventory. So Administrator can search the particular chemical by its common name.

Chemistry Laboratory Management System

View listed Chemicals

Here You Can Search By [Chemical's Common Name](#)

Search

[Click Here to Add New Chemical](#)

Chemical_ID	Common Name	IUPAC Name	Formula	Physical State	Boiling/melting point	Hazzards	Expiry Date	Minimum Required Amount	Amount		
3	Hydrochloric Acid	hydrochloric acid	HCl	Solid	110	Corrosive	2017-04-06	500	5000	Update	Delete
4	Sodium hydroxide	sodium oxidanide	NaOH	Liquid	318	Corrosive	2017-03-25	450	10000	Update	Delete
5	Sulfuric acid	sulfuric acid	H2SO4	Liquid	335	Corrosive	2017-04-14	500	10000	Update	Delete
6	Nitric acid	nitric acid	HNO3	Liquid	83	Corrosive	2017-05-31	450	5000	Update	Delete
7	Potassium hydroxide	potassium hydroxide	KOH	Solid	360	Corrosive	2017-04-20	50	2000	Update	Delete

[Show All](#)

Figure B.4: Main page of chemical inventory

Administrator should click the “Click here to Add new chemical” link to add chemical (Which is in the main page of chemical). Then the administrator will be redirected to add chemical page”. Then he/she can be added a new chemical into the system.

Chemistry Laboratory Management System

Add New Chemical

Common Name :

IUPAC Name :

Formula :

Physical State :

Boiling/Melting Point :

Hazzards :

Expiry Date :

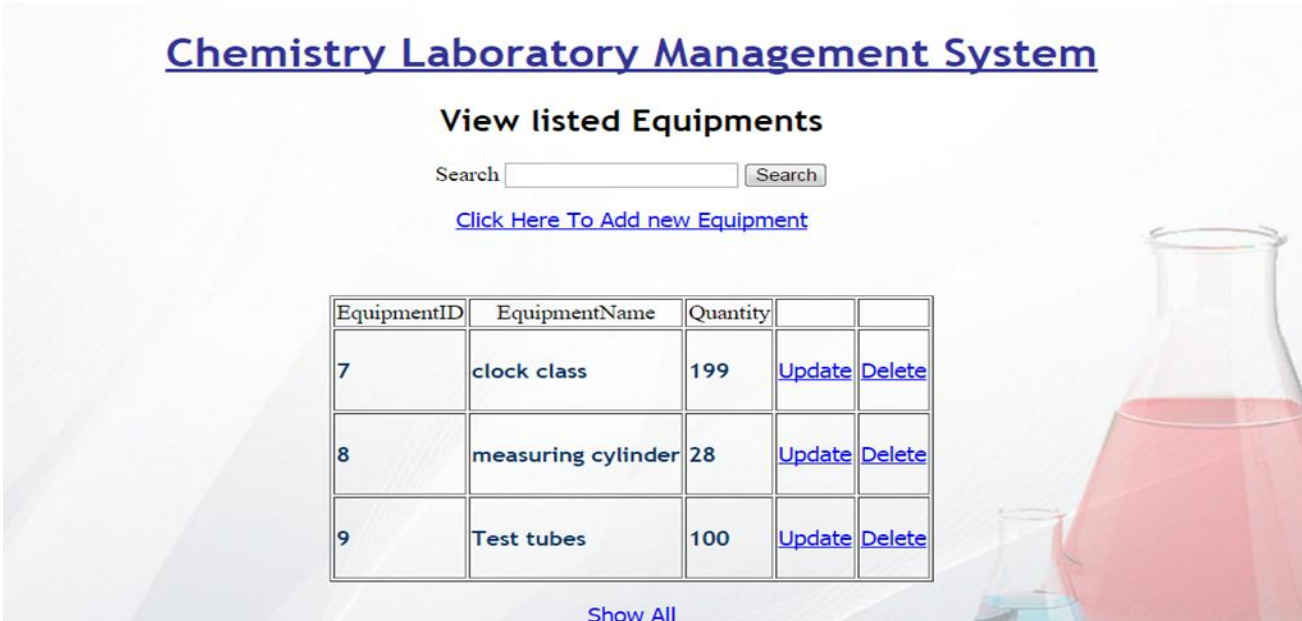
Minimum Required Amount :

Amount :

Figure B.5: Add Chemical page

Equipment Inventory page

If administrator clicks “Equipment”, then main page of equipment will be displayed. All equipment can be seen with related quantity. Update and delete options also given for each equipment. Search option is available in the main page of equipment inventory. So Administrator can search the particular equipment.



Chemistry Laboratory Management System

View listed Equipments

Search

[Click Here To Add new Equipment](#)

EquipmentID	EquipmentName	Quantity		
7	clock class	199	Update	Delete
8	measuring cylinder	28	Update	Delete
9	Test tubes	100	Update	Delete

[Show All](#)

Figure B.6: Main page of equipment

Administrator should click the “Click here to Add new equipment” link to add equipment (Which is in the main page of equipment). Then the administrator will be redirected to add equipment page”. Then he/she can be added new equipment into the system.



Chemistry Laboratory Management System

Add New Equipment

Equipment Name:

Quantity:

Figure B.7: Add equipment page

Claim Page

If administrator clicks “Claim”, then main page of claim will be displayed. All claim details can be seen in the main page of claim. Delete options also given for each Claim. Search option is available in the main page of claim. So Administrator can search the particular student’s claim using his/her index number.

Chemistry Laboratory Management System

Search Claim by using student's index no:

Search

ClaimID	PracticalCode	ClaimDate	StudentName	IndexNo	EquipmentID	EquipmentName	Quantity	
24	CH251	2016-12-01	Thevaruban	BS932	8	measuring cylinder	7	Delete
27	CH253	2017-03-01	Sajan	PS1356	9	Test tubes	2	Delete
29	CH153	2017-02-22	Rajasundram	PS1456	8	measuring cylinder	1	Delete
30	CH351	2017-02-08	Thevaruban	BS932	9	Test tubes	2	Delete
31	CH254	2017-02-17	Sarujan	BS945	7	clock class	1	Delete

[Show All](#)

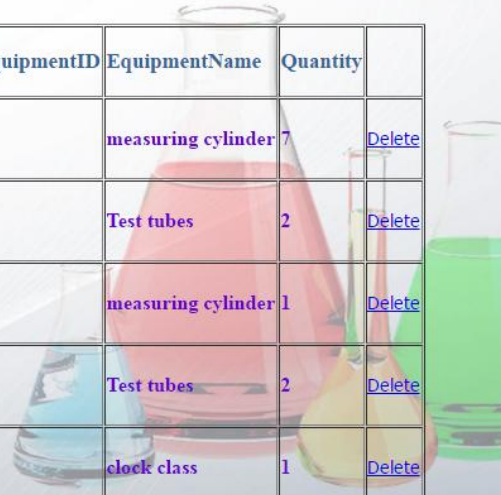


Figure B.8: Main page of claim

Administrator can search a student's claim by using his/her index number.

Chemistry Laboratory Management System

Search Claim by using student's index no:

Search

ClaimID	PracticalCode	ClaimDate	StudentName	IndexNo	EquipmentID	EquipmentName	Quantity	
24	CH251	2016-12-01	Thevaruban	BS932	8	measuring cylinder	7	Delete
30	CH351	2017-02-08	Thevaruban	BS932	9	Test tubes	2	Delete

[Show All](#)

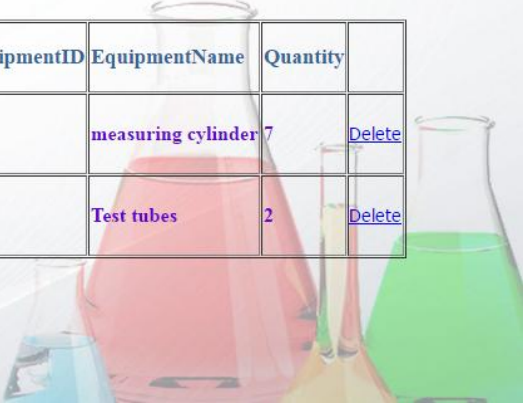


Figure B.9: Search a claim

I gave the following questionnaires to review prototype user interface designs.

1. Choose your designation
 - Head
 - Lecturer
 - Demonstrator
 - Technical officer
2. When did you join in the chemistry department?
 - Recently
 - More than 2 years
 - More than 5 years
 - More than 10 years
3. Have you ever interacted with a system like before?
 - Yes
 - No
4. Are you satisfied with the system features provided for you?
 - Yes
 - No
5. Rate the “User friendliness” of this system
 - Very Poor
 - Poor
 - Medium
 - Good
 - Very good
6. Would you expect any further modifications of this system? Please leave your comment below?

.....

.....

.....

.....

.....

Figure B.10: Questionnaire for interface of the system

Usability test form of chemistry laboratory management system	
Your Name	
1	The User interface designs of chemistry laboratory management system?
	<input type="checkbox"/> Very Poor <input type="checkbox"/> Poor <input type="checkbox"/> Good <input type="checkbox"/> Very Good <input type="checkbox"/> Excellent
2	“Manage user” feature of the system?
	<input type="checkbox"/> Very Poor <input type="checkbox"/> Poor <input type="checkbox"/> Good <input type="checkbox"/> Very Good <input type="checkbox"/> Excellent
3	Chemical inventory features of the system?
	<input type="checkbox"/> Very Poor <input type="checkbox"/> Poor <input type="checkbox"/> Good <input type="checkbox"/> Very Good <input type="checkbox"/> Excellent
4	Equipment inventory features of the system?
	<input type="checkbox"/> Very Poor <input type="checkbox"/> Poor <input type="checkbox"/> Good <input type="checkbox"/> Very Good <input type="checkbox"/> Excellent
5	Students’ claim features of the system?
	<input type="checkbox"/> Very Poor <input type="checkbox"/> Poor <input type="checkbox"/> Good <input type="checkbox"/> Very Good <input type="checkbox"/> Excellent
6	Practical entry features of the system?
	<input type="checkbox"/> Very Poor <input type="checkbox"/> Poor <input type="checkbox"/> Good <input type="checkbox"/> Very Good <input type="checkbox"/> Excellent
7	Generating report facility of the system?
	<input type="checkbox"/> Very Poor <input type="checkbox"/> Poor <input type="checkbox"/> Good <input type="checkbox"/> Very Good <input type="checkbox"/> Excellent
8	User friendliness and performance of the system?
	<input type="checkbox"/> Very Poor <input type="checkbox"/> Poor <input type="checkbox"/> Good <input type="checkbox"/> Very Good <input type="checkbox"/> Excellent
9	Understandability of the error messages and ease of using?
	<input type="checkbox"/> Very Poor <input type="checkbox"/> Poor <input type="checkbox"/> Good <input type="checkbox"/> Very Good <input type="checkbox"/> Excellent
10	Comments
11	Signature

Figure B.11: User acceptance form for administrators

Usability test form of chemistry laboratory management system	
Your Name	
1	The User interface designs of chemistry laboratory management system?
	<input type="checkbox"/> Very Poor <input type="checkbox"/> Poor <input type="checkbox"/> Good <input type="checkbox"/> Very Good <input type="checkbox"/> Excellent
2	Chemical inventory features of the system?
	<input type="checkbox"/> Very Poor <input type="checkbox"/> Poor <input type="checkbox"/> Good <input type="checkbox"/> Very Good <input type="checkbox"/> Excellent
3	Equipment inventory features of the system?
	<input type="checkbox"/> Very Poor <input type="checkbox"/> Poor <input type="checkbox"/> Good <input type="checkbox"/> Very Good <input type="checkbox"/> Excellent
4	User friendliness and performance of the system?
	<input type="checkbox"/> Very Poor <input type="checkbox"/> Poor <input type="checkbox"/> Good <input type="checkbox"/> Very Good <input type="checkbox"/> Excellent
5	Understandability of the error messages and ease of using?
	<input type="checkbox"/> Very Poor <input type="checkbox"/> Poor <input type="checkbox"/> Good <input type="checkbox"/> Very Good <input type="checkbox"/> Excellent
6	Comments
7	Signature
.....	

Figure B.12: user acceptance form for other clients