CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

A library is an assemblage of resources which are made accessible to a defined set of people for referencing or borrowing; it is an essential part of educational and information sector of any institution. In the real sense, there are four different types of library which are special library, university library, public library and academic library. According to KANU, C., Okechukwu Agu(CSSp), R., Bartholomew, and Egwuonwu, U. (2020) Academic library is the type of library that is mainly for the tertiary institutions such as colleges of education, universities, polytechnics *et.cetera*. It is an essential part of institutions which assist in the improvement of learning and knowledge dissemination for the purpose of meeting the information needs and timely provision of information in the universities (Olorunfemi & Ipadeola, 2021). Before the commencement of the computer or digital age we are, library activities have been practicing manually and it was stressful and attracts many difficulties to the library users and the librarian. In the manual way of managing library, many problems could arise, such as loss of books or other library materials, complexity to search for books in case of large library, and damage to books either by rodents or water spillage. But nowadays, the library activities have been automated or digitalized in order to overcome the shortcomings of the manual way of managing library. This automation is what is referred to as electronic or digital library management system. According to Araya (2020) promotion of digital reading habits for users, advance knowledge of the users in every aspect of technology and filling of the gaps in the physical library are the reasons for the implementation of the computerized or digital library management system.

Digital Library management system is the software which is developed with the overall objective of providing an effective and efficient way of acquiring, cataloguing, searching, retrieving, downloading and maintaining library materials. It is used and controlled by the library staff categorically to manage the library using computerized system, where librarians can record numerous transactions like the issue of books, the return of books, the adding of new books, the adding of new members and removing of the existing members. A Web-based library management system is seen as a collection of online databases of digital objects that can include text, still images, audio, video, digital documents, or other digital media formats accessible through the internet. It is an extension of the computerized system, which makes it possible to access the data on the Internet (Udo-okon, 2022).

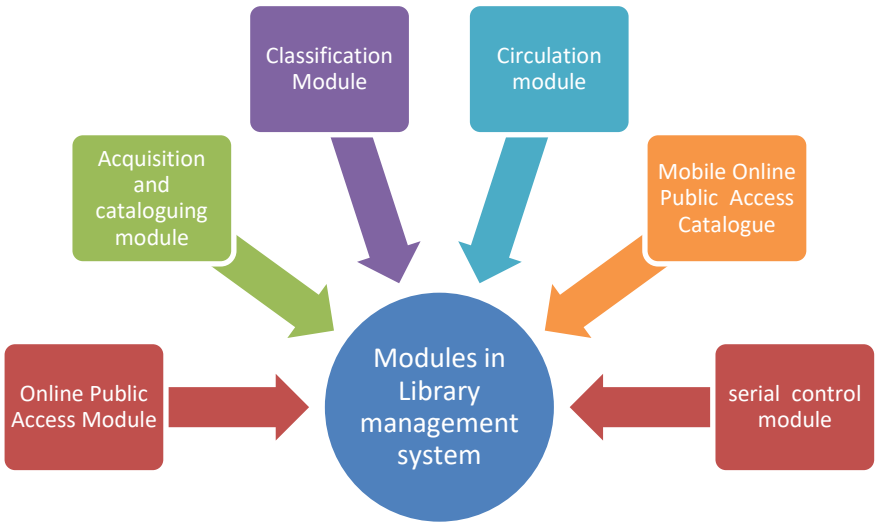

Figure 1.0: Modules in Library management system

An automated or integrated library management system, there are a number of essential modules that enables the effective and smooth running of the library. These modules include acquisition module, cataloguing module, circulation

module and online public access (OPAC) module. The acquisition module is majorly designed for the management of the purchase orders and vendor information of the library. From this module, data are downloadable to the cataloguing module. For this reason, the acquisition module is completely connected with the cataloguing module. In the cataloguing module, the addition of new records into the database, updating the existing records, searching for the records and downloading of required materials are easily done. Another important module in the integrated library management system is the online public access module, in which users are allowed to use simple or advanced search to search the catalogue of the library from their various destinations. Asides from the simple and the advanced search, users can search the library catalogue using the basic searches. The basic search is done by searching the catalogue in relation to the title, author, subject or the keyword (Abdullah, 2021). The circulation module is the library module that is concerned with the processes of lending and procedures involve in loaning of library information materials or resources to the authorized users of library, which aims to enhance the accessibility of different available materials or resources to the users in relation to their needs (Ilorah, C., Ph, C., Amaka, F., and Ph, N. 2022). In every library system, this module is concerned with the charging and discharging of library materials, addition of new users, charging of fines for the overdue of the loaned materials and the processes involve in returning these materials to the library over a stipulated period of time.

A web based application will be developed for this study for the smooth and effective running of the library activities ranging from cataloguing, registration of new users, removal of the existing user, loaning of available library materials, authenticating the accessibility of library resources by adopting V-model and employing hypertext markup language, bootstrap, JavaScript, hypertext Preprocessor, Node.js, and MySQL for the database.

1.2 Statement of the Problem

Digital library management system is a system that allows the user to keep track of both the books and customers in an effective way, and it allows physical libraries to be converted into digital libraries. The essentiality of library in any academic environment mostly in the educational institutions and the underlined shortcomings of manual operation of library activities have led to this study, by developing a digital or electronic system for the proper management of the library activities.

Chughtai, Malik, Raza and Saleem (2022) developed an integrated library management system using hyperledger fabric, and the system can only works on Linux operating system, this proposed research work will be adapted to work perfectly on Windows operating system. Abrizah (2021) automated a web based library management whereby Microsoft visual interDEV was adopted as web application tool, the automated system operates in a consortium, and it allows room for downloading bibliographic records and sharing of information among the consortium members, but the consortium is limited to four schools only. Shanmugam and Baalachandran (2020) developed a library management system but the system was a desktop application. Chanda (2020) developed an android based library management system using android Studio that consists of Extensible mark-up language and java language. the gap in the system was the usability of the system is limited only to the smartphones users.

Platform dependence and limitation of the number of users that can easily access the developed systems are the major drawbacks of the system that have been in existence. In any academic based application particularly library management system, the accessibility should be generalized to every member of the institution irrespective of their devices.

This study will overcome the drawbacks of the existing library management system by developing a web base application that will give room for the users to access it on their personal computers and smartphones by adopting hypertext markup language, cascading style sheet, Bootstrap, JavaScript and MySQL to develop a system that will work perfectly on web application and be accessible to authorized users.

1.3 Aim and Objectives of the Study

The aim of this study is to develop an automated web-based library management system that will enable and promote effective and efficient way of accessing, searching, retrieving, cataloguing and maintaining available materials in the library using agile; while the specific objectives are to:

1. Develop a responsive web application for a web based library management system.
2. Create an automated question generator for the course taught in the university.
3. Generate an automatic detail of borrowed materials with due date notifications.
4. Implement and evaluate web-based application.

1.4 Methodology

The method, technique and tool to be adopted for this project will be discussed in this section and as well as how they will be used and what they will be used for along the attempt to achieve the stated aim and objectives will be discussed in this section.

1.4.1 Development of a responsive web based application

All users intend or require a web application that will be platform independent, that is an application that will adapt itself to different

platform, devices and screen sizes, and as well the system that will not block the user from accessing the website irrespective of the users device. Bootstrap 5 together with cascading style sheets (CSS) features such as flexible grids and layouts, image and efficient use of cascading style sheets media queries will be adopted for establishing this responsive web based application, so that as the users migrate from their laptop to Ipad the application will shift to accommodate image size, resolution and scripting abilities automatically.

1.4.1.1 Adoption of Bootstrap for responsive website

The correct tags for meta will be specified, detailing meta name, content, device's width and initial scale. For the responsive Navbar of the website, the position of the Navbar in the container will be specified; for a sticky Navbar attribute fixed top or bottom will be used, and here the sizes of the Navbar can be chosen to be small, medium or large.

1.4.1.2 Adoption of Cascading Style Sheets for responsive website

Cascading style sheets (CSS) is majorly used for designing or styling web pages and more also it is essential for building responsive websites with the proper assignment of the properties, attributes and selectors in cascading style sheet. The use of relative units such as rem for the font size greatly contributes to the responsiveness of different text in the content of a website.

Instead of using fixed sizes, width and height properties will be used as recommended for obtaining a responsive website, whereby maximum or minimum value can be specified. Making use of grids fluid and fluid images are another key properties that enable the column of the websites to be adapted to the width in accordance with the size of the screen.

Media queries help to ease the accessibility of a website on different devices like tablet, mobile, or desktop base on responsiveness. The media queries are of two types which are minimum width property and maximum width property which refer to the starting point of the size of window and the end point of the size of the window respectively. This media queries will be adopted to specify for the small devices (landscape phones), medium devices (tablets), large devices (desktops), and extra-large devices (large desktops).

1.4.2 Creation of automatic question generator

JavaScript will be adopted for the generation of automatic questions by setting up the structure of the programme, the functions in the programme includes the function that will store the questions, function that will display the questions, function that will store the result and lastly a function that will monitor the submit button. The programme will find the chosen answer for every question, if the answer is wrong or correct it will respond accordingly and finally show the number of correct answers out of the total.

1.4.3 Generation of Notification through E-mail

A JavaScript library known as simple mail transfer protocol (SMTP) which is basically used for sending emails and it is for outgoing mails alone. Correct simple mail transfer protocol server is needed to be provided after the client's email has been set up, and Gmail configuration is required for the effective use of simple mail transfer protocol (SMTP).

1.4.4 Evaluation of the System using Selenium testing tool

Selenium is one of the most suitable tools that help in automating testing software and it is mainly adopted for performing functional testing of web applications. It consists of selenium IDE where scripts together with record and playback interactions from the browsers can be quickly created; there is

selenium grid where multiple configurations and machines can be tested at the same time, also it includes selenium web driver and bindings which help in driving the browser for testing.

1.5 Significance of the Study

The importance of this study is centered on overcoming the noticeable increase in number of failures in the institutions across the nation due to improper management of digital library management system. The development of this digital library management system intends to overcome the shortcomings of the manual ways of managing library system. This study will benefit not only the students of the university but it will as well be advantageous to the university lecturers to easily upload materials to the library and at the same time have access to a number of available library materials regarding their respective course of study and general studies.

1.6 Scope of the Study

This study is mainly concerned with the management of electronic books and other related materials in the library, and it focuses on the elimination of the high time consumption required to search through library materials such as reference materials, reserve materials, journals, textbooks, slides *et cetera* and to reduce the stress of searching catalogue.

1.7 Motivation for the Study

There has been high demand for library management system most especially the automated library management system in any of the educational setups, either at the secondary or the institutional level around the world. Adoption of this digital library management system will serve as a panacea for the reduction of the poor performance of students due to untimely access to library; with this

web application based digital library management system, the students will have access to the library materials at any time of their choice and at any of their preferred locations.

1.8 Justification of the Study

Various systems have been developed for the digital library management system but there are still enormous number of limitations or drawbacks to these systems such as lack of an interface that will generate the details of the borrowed material with the registration identification number of the borrower, and there is no automated questions generator for the readers to brainstorm with while reading or after reading. In this study, a web based digital library management system that will enable the generation of educative questions for the library users will be developed.

1.9 Organization of the Project

In chapter two of this study, different research works that have been done by various researchers will be discussed, and the discussion is referred to as related work or literature review; chapter three gives the detail description of the methods and materials adopted for achieving the aim and objectives of this study, chapter four discusses the results obtained from the adopted methodology, while chapter five gives the summary, recommendations and conclusion of the study.

1.10 Definition of Terms

Cataloguing

Philosophy & Nwachi (2021) define cataloguing as the method of classifying library materials with respect to their distinguishing features which helps in recognizing and differentiating various materials from the other. Its activities include assignment of subject heading, description of library information

materials, systematic arrangement of the library resources, catalogue and online public access catalogue (OPAC) maintenance, and catalogue cards production *et.cetera.*

Digital Library

Digital library also known as electronic library is the advancement and development of library automation technology with an essential goal of organizing and making enormous volumes of the available virtual evidence in a well arranged and orderly manner (Su & Chen, 2022). According to Dita (2022), it is a form of system which utilizes computer and computer networks as the storage, and which allow access to different contents having unlimited number of resources. With digital library, published books are easily converted into digital forms such as electronic book and modified the converted published books into digital formats like audio, HTML, PDF, video or services by making use of computer and network. Unlike the manual library, electronic books can easily be downloaded by the user and specific library materials can be quickly located.

Internet Service

This is the service that gives access to a large number of information such as sound, graphics and software through the internet connection. A system is required to be connected to the World Wide Web before gaining access to the internet.

Library

According to Chanda (2020), a library is an organized collection of resources to provide a convenient way of accessing library resources physically or digitally, with optimum intension of educating and advancing the entire society.

Library Management System

Tsega (2020) defines library management system as an application which is mainly developed for tracking all the library activities electronically, and it is controlled by the librarian specifically using computerized system to keep records of the issue of books, library loans and various transactions in the library. The system comprises of various data ranging from list of books available in the library, the number of issued books, fines record, charge record, list of returned books *et.cetera* (Dita, 2022) .

Management Information Systems

This gives reports related to the library to help librarian in the extraction of important information concerning the library transactions. The accuracy of management information system contributes to better decision making.

Online Public Access Catalogue (OPAC)

Online library for library and information science defines OPAC as an acronym for online public access, which comprises of bibliographic records detailing journals, books and other library materials. Adegun, Akinola, Oyewumi and Adepoju (2021) added that online catalogue can be searched by subject, title, author or keywords and the records of the users can be printed and can be easily exported to an e-mail account, and it allows users to make request for materials from different libraries with the help of inter-library service.

Serial control

This is a module in library management system which allows the librarians to control and monitor processes like generation of accurate management information system reports, cancellation of reports, renewals of library materials and subscription.

Web Application

According to Ummary (2022) defines web application as any software program that make use of an of the web browsers (such as Firefox, Safari, chrome *et cetera.*) and other web technology to carry out tasks over an internet or the intranet. For university business, web applications are also developed internally by web application developers.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

In this chapter, the recent and the past works that have been put in place by different researchers and developers on digital library management system will be discussed. Various approaches and methods have been used by different researchers which include the application of data mining, deep learning, machine learning, and many algorithms (such as PAM algorithm) for the effectiveness and automation of library management system. The identified gaps and weaknesses of the reviewed works will be adjusted by this literature review to adapt the study to the present and modern age.

2.1 Web Application

Web application is any form of applications that can have interactions with a network, it can also be called client or server applications (Cloud, 2022). Web application is often store on a remote which can be easily accessed via the use web browsers such as chrome, Mozilla Firefox, Safari, Microsoft edge *etcetera.*

2.1.1 Advantages of Web Application

I. Web applications can be accessed via various laptops, desktop or mobile platforms.
II. The same version of an application is accessible by multiple users.
III. They are flexible because they can be divided into static and dynamic applications.
IV. They can be used without the need for installation for it can be run locally or on a web server.

V. Different technologies can be adopted for developing web application and this enables web applications to do variety of tasks.
VI. With the use of web browsers, web applications can be accessed from any location in the world.

2.1.2 Types of Web Application

Web application is any form of applications that can have interactions with a network, it can also be called client or server applications (Cloud, 2022). Web application is often store on a remote which can be easily accessed via the use web browsers such as chrome, Mozilla Firefox, Safari, Microsoft edge *etcetera.* The different types of web application are listed and explained as below.

2.1.2.1 Static Web Application

The simplest web applications on the web are the static web applications; and they involve the collection of hypertext markup language (html), cascading style sheet (css) and JavaScript for the efficient and proper displaying of the essential content and information. The static web applications do not support personalization, until the page is fully loaded the apps will not change and they allow the inclusion of animated objects. Static web applications work perfectly in offline mode and they do not require the installation of third party software before the web application can be accessed. Example of this type of web applications is blog post.

2.1.2.2 Dynamic Web Application

Dynamic web application is another type of web applications in which live data based on the requests of the users are displayed. They are more complex than the static web apps and include a variety of interactive features and strategies

for highlighting products or services. The private and public displayed on the website is typically stored in databases, which allows the website administrators to edit information and add interactive elements to the web applications. Some of the languages used for building dynamic web applications are PHP, JSP, and ASP.NET. Examples of dynamic web applications are Facebook, Twitter, LinkedIn and Netflix.

2.1.2.3 Single-Page Web Application

Single-page web applications or single-page apps are applications in which all their data are handle on a single web page, which simply means the interaction between the application and the user is mainly conducted with one page. These types of web applications are faster compare to the traditional web applications because they do not require server to apply their logic they rather implement it directly in the web browser. Examples of the single-page web applications are Gmail and PayPal.

2.1.2.4 Multiple-pages web Application

A multiple-page web application is the web application whereby whenever the user navigates to a different page the whole web application reloads. The common example of this type of web application is a webmail application. In the case of the webmail, the email client can be opened by the user, messages can be read in the inbox folder, new messages can be composed and the composed messages can be sent to other users. These stated activities are done via the same interface but they were realized by different pages. Users can therefore interact with the application in different ways as a result, but the multi-page applications will be used. Example of multiple-pages application is Google docs.

2.1.2.5 E-Commerce Web Application

An electronic commerce web application abbreviated as e-commerce web application, it is all about any form of businesses that gives room for the purchase of goods or services via internet. It entails the provision of information regarding the products, removal of outdated products, addition of new products, electronic payments and giving a user-friendly interface. Examples of e-commerce web applications are Amazon and eBay.

2.1.2.6 Portal Web Application

A portal web application is the type of web application that offers access to numerous links and pages; they are frequently used for news sites, online shopping, and search engines. The fundamental concept of portal web applications is to browse through various contents in the same site. Portal web applications are the greatest options for the organizations, companies, and businesses that wish to create user interfaces that suit the requirements or needs of the target audience. In this type of web application, it is only the authorized or registered users that can access the portal and the service provider can monitor what the user performs. Examples of portal web applications are Cousera and Udemy.

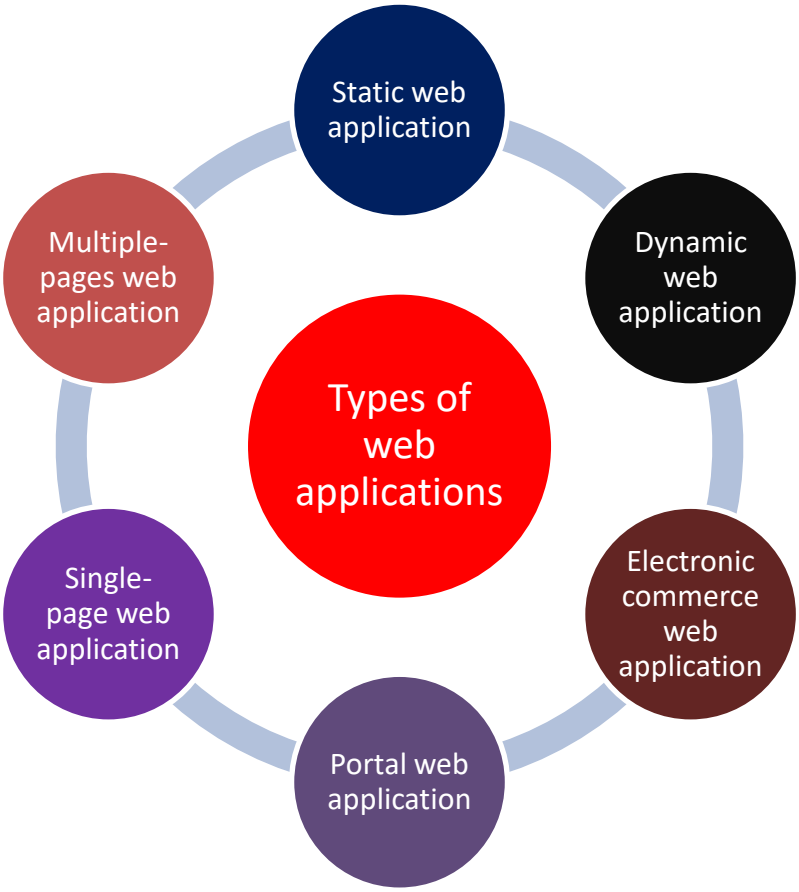

Figure 2.0: Different types of web applications

2.2 Agile Model

Agile models as one of the software development life cycle models were developed to address or minimize the shortcomings or challenges faced in adopting traditional models such as waterfall and v-models. The various types of agile approach majorly employed for software development include Kanban, Scrum, Extreme programming and lean. The main focus of agile model or approach is to enhance the active involvement of customer and extensive interaction between the developers and customers during the development process. For achieving the collaboration between the developers and customers, agile approach for developing software also entails some practices;

some of which are epic and user stories, user stories, Burndown chart, Burnup chart, stand ups, and pair programming (Ghimire, 2022).

Table 1 some of the practices used in Agile model

practice	**definition**
Pair programming	The practice whereby two developers team work in concurrency at the same workstation.
Definition of done	This addresses the stage at which the deliverables are ready to deliver to a customer after all the given or stated acceptance criteria for the deliverables have been meet.
Burnup or Burndown chart	A chart depicting the record of works that have been successfully done and those that are to be done in the project.
Continuous integration	It is concerned with the combining work that have been done by developers when changes arise.
Scrum board	This is mainly for the visualization of the progress or status of work in each sprint.
Refactoring	This is the act of improving the existing of a code without disrupting the external behavior or function of the code.
Kanban board	A tool used for the visual display of the progress of workflows, project task and communications.

2.2.1 Phases in Agile Model

Babatope (2022) defined agile methodology is an incremental process that focuses on the promotion of the benefits in the effective collaboration and communication between the developers and the customers which give rise to the delivery of a good quality product that satisfies the requirements of the customer and the cooperate teamwork among the team developers. This methodology comprises of six different phases, which are:

1. **Concept:** This is the first phase in agile methodology, this is the phase where the required efforts to build the project, the duration or period required for the completion of the project, the objectives of the project, benefits of the project and more are clearly stated and well defined.
2. **Inception:** It is the phase that stands as the planning phase for the time estimation of the project, starting from specifying the agile framework to be adopted, to identifying the features, workflows and the description of the final product.
3. **Design development and construction:** The actual development process is established in this phase to allow the team members such as programmers, designers and developers to start their given project as scheduled and planned.
4. **Testing or Integration:** the quality assurance team come in for the examination of the performance of the developed products to check for the possible errors that could have risen during the development which might have hindered the system to function as expected.
5. **Implementation:** this is the phase that is next to the testing phase, in this phase the version that have been tested by the co developers and

affirmed to be error free, the developer releases this version or the final version after the developers are assured about the application.

6. **Retirement or Feedback:** This is said to be the last phase in agile development methodology, and it is centered on the feedback received about the developed product and work on the feedback due to the minor changes or updates made to the application.

Figure 2.1: Phases of Agile Model

2.2.2 Different Agile Software Development Methods

Agile methodology as one of the software development life cycle models, with the main focus of enhancing the active involvement of customer and extensive interaction between the developers and customers during the development process. For achieving the collaboration between the developers and customers, agile approach for developing software also consists of some development methods which are crystal, Kanban, extreme programming, scrum and dynamic system development; these are depicted in figure 2.2 below.

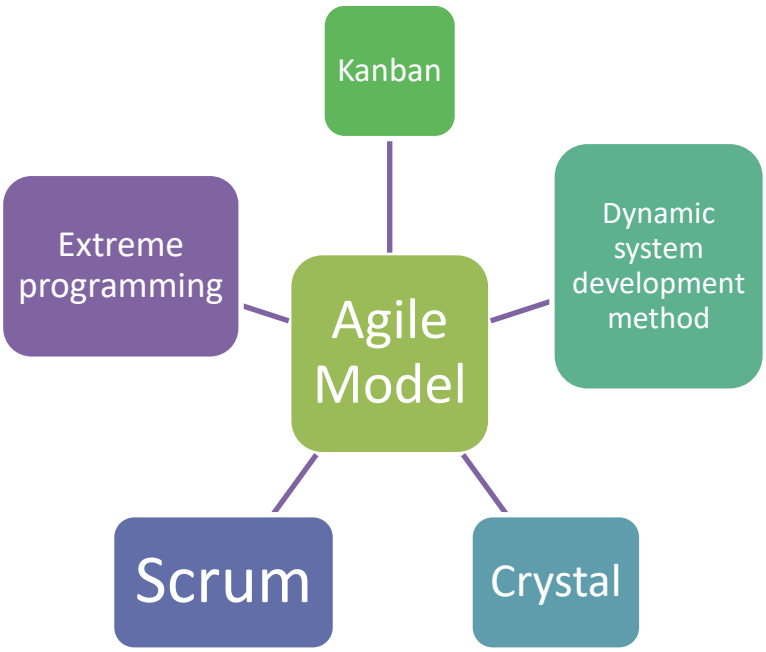

Figure 2.2: Agile software development methods

2.2.2.1 Scrum Method

Scrum method is an important implementation of agile framework which was developed for managing project; it is concerned with delivering of high quality product within a short period of time. Scrum method creates a sprint which aids incremental development of the system and different artifact that constitute its work were produced, and it is the commonly used type of agile methods. Its simplicity and focus on the software management issues have contributed to its popularity and applicability in any domain compare with the rest of the agile methods.

Scrum has three different phases, these phases are:

1. **The initial phase:** This is the first phase of scrum that outline planning phase at which the design of the system is outlined and the objectives for the system are developed and it is also referred to as iteration 0. At this

iteration 0, required resources, necessary tools and the project team definition are clearly stated.

2. **The development phase:** It is the second phase of scrum method and it is can be referred to as the sprint-phase, it comprises of cycles that are sprint-based, and the output gotten from each of the cycles is the value that is incrementally added to the system.
3. **The project closure phase:** This is the last phase of the scrum method, it is where the latest version of the product is ready for release and it can be evenly distributed. And it is the phase where the user manuals and documentation of the product is released.

Advantages of Scrum Method

1. Division of the software product into a smaller understandable modules increase the shared knowledge.
2. Conduction of various meetings via development process enhances the visibility of feedback and communication with the product owner, hence transparency.
3. Simple process

Disadvantages of Scrum Method

1. Scrum method does not have any specific prescription of how to apply the method for engineering practices.
2. Lack of precise definition of responsibilities for the members of the team could give rise to violation of responsibility.

2.2.2.2 Dynamic System Development Method (DSDM)

Dynamic system development method is another agile software development that makes use the approach of rapid application

development. Developing high quality software is the main aim of this method as an incremental iterative approach, and it emerged rapid application's framework in the year 19997. Setting and defining required resources and time for the project is the main idea of dynamic system development method, then this method gives an opportunity for the adjustment of the amount of functionalities that can be completed with the estimated resources and scheduled time. It is quite different from the traditional methods in the sense that, in the traditional methods; required functionalities are firstly predefined before the allocation of time and resources.

Dynamic system development method consists of five phases which are:

1. **Feasibility study phase:** It is the first phase of dynamic system development method, and it is the phase where the suitability and appropriateness of adopting dynamic system development method for the project at hand is carefully studied. Technical requirement specification and risk analysis are done in this phase, and they give report about the feasibility and development plan as result.
2. **Business study phase:** This is the second phase of dynamic system development method, the development team and the business experts hold a meeting to specify the requirements of the users and to prioritize the required functionalities in the system. It is in this step that the technologies such as Entity relationship diagrams, architecture of the system, and object model are specified.
3. **Functional model iteration:** the main aim of this phase is to answer what, why and how questions; that is, what to develop, when to develop it and how it will be developed. Also the functional and non-functional requirements are analyzed.

4. **Design and build phase:** This is another phase of dynamic system development method where the previously identified functional and non-functional requirements are implemented and coded, and it will be delivered to the users for testing.
5. **Implementation phase:** This is the last phase in dynamic system development method where the software together with user manual is totally handled to the users. If the system functions or works as expected or required by the users this phase brings about the last process but if not, the process will be restarted to suit the user requirement.

Advantages of Dynamic System Development Method

1. It can give instructions development techniques and other aspects of project.
2. There is early delivery of the product.

Disadvantages of Dynamic System Development Method

1. There is less consideration on the size of the team and length of the iterations.
2. Dynamic system development method does not have critical consideration on the project.

2.2.2.3 Extreme Programming Method

This is the one of the first agile methods that was developed with the overall objective of addressing the shortcoming of the convolutional process of software development in the perspective of frequently requirement changes. It is a methodology which was developed to suit the object-oriented type of project that support pair programming. This method comes with attempts to satisfy customers and to reduce the high cost that changes in requirement

could result to, whereby multiple short cycles replaces the long development cycles. There are many different roles in extreme programming some of which are programmer, customer, tester, coach, manager and tracker. Extreme programming has five major key values, and these values are:

I. Communication
II. Simplicity
III. Feedback
IV. Courage and
V. Quality work

Extreme programming consists of six different phases, these phases are:

1. **The exploration phase**: It is the phase where the available resources for example practices, technology and tools are introduced to the project team. In this phase, the possible system architecture is detected by building a sample prototype of the system, and the period last for no more than a few months.
2. **The planning phase:** This is the next phase after the exploration phase, and it is concerned with the scheduling and effort estimation whereby the programmers agreed on the schedule and the estimation made.
3. **The iteration to release phase:** This phase comprises of various iterations and the duration for each of the iteration is stipulated within one to four weeks. In the first iteration, the overall architecture of the system is created through the appropriate selection of stories. Moreover, at the end of every iteration, functional testing is carried out by the customer, while the output of the last iteration will be ready for a production system. The two key practices in this phase are refactoring and pair programming.
4. **The production phase:** this phase embraces more testing and evaluation of the system's performance before the release of the product to the customer, after the delivery of the first release of the system to the

customer, the system is required to be kept running along the production of new iterations.

5. **The Maintenance phase:** Maintenance is the incorporation of new members into the team that might be supportive to customer tasks.
6. **The death phase:** Death phase is the last phase of the extreme programming where changes in requirement are no more and the implementation of the developed system is meets the expectation of the users.

2.3 Conceptual Framework

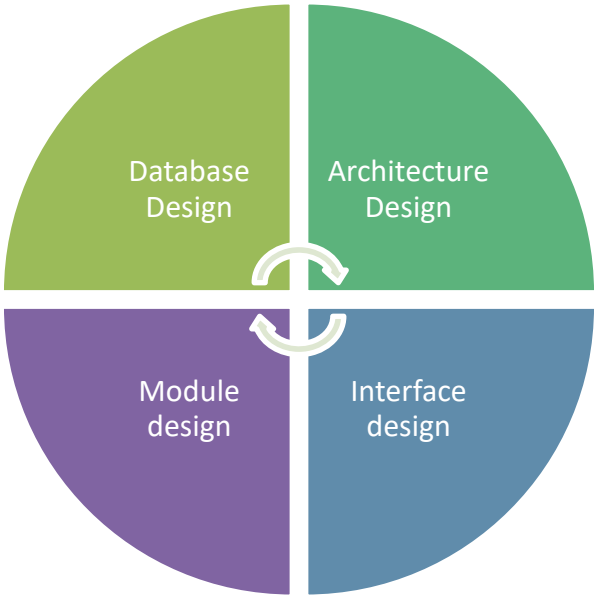

Figure 2.3: Conceptual framework

2.3.1 Database design: This monitors the prevention of duplication of data and information; it is a way through which the data model of a database is produced. The required logical, conceptual and physical storage parameters are encompassed in this data model for the creation of a design in data definition language. This stage consists of different stages that are generally

supported out by database designers, these stages are conceptual design, logical design and physical design.

2.3.2 Architecture Design:

This phase is denoted as the high-level design, where the architecture of the computer and software are design. The architecture design also emphasizes that the model at hand should have clear understanding of the list of units, functionalities of each unit, the relationships between their interface, architectural diagram, details of the technology, dependencies and database tables. The deliverables from this phase are architecture design and software and hardware specification.

2.3.3 Interface Design

The interface design or user interface design concentrates more on what the users are expecting the system to do and assuring that the features of the system have easy accessibility and understandability. The interaction design, visual design and information architecture are the essential concepts that constitute to interface.

2.3.4 Module Design

Module design is also referred to as the low-level design; it involves the fragmentation of the intended system into smaller units or modules (Araya, 2020). This is an important concept in developing a system, and it will be adopted in this intended system since it comprises of different modules.

2.4 Theoretical Framework

Data Envelopment Analysis (DEA)

Data envelopment analysis is a useful simple technique that enables the assessment of productive units through the use of multiple inputs and outputs, this technique can also be used together with the zero-sum gains (ZSG) models to assist in allocation of resources.

Categorically, these approaches serve as assisting agents for the managers in assessing the library performance and for the resources reallocation within an automated library management system, either public or university libraries. It involves two steps approach, whereby the first step is on classic CCR model and the second step is basically on the zero-sum gains data envelopment analysis CCR (ZSG CCR DEA) model.

As shown in this overview, to measure the efficiency of a library there are various inputs and outputs indicators; and the common inputs are library collection, library staff and acquisition, while circulation is the most commonly used output (Bernardo, De Souza, Moreira Lopes, and Rodrigues (2020).

2.5 Related Works

Shi (2022) applied fuzzy C-means clustering algorithm for the development of digital library management system, whereby theoretical analysis together with interview methods of application for the evaluation of an existing library management system were carried out. While error rate cross estimation method was adopted for the evaluation of the accuracy of the cluster analysis and at the same time for the verification of the performance of the system. With the system, big data can be easily analyzed; results evaluation and conclusion drawing are done on mathematical base as a result of the fuzzy c-means algorithm that was applied.

A case study approach was used for designing web-based library management system, and Java programming language, hypertext preprocessing (PHP), hypertext markup language (HTML) and database MySQL were adopted as the design parameters while the data definition language (DDL) was used for the creation of the database. With the system, users can have access to unlimited number of electronic books; there is provision for the information repository which involves relationship among users, members and admin, and records were provided by the system through Wi-Fi (Araya, 2020).

Shanmugam and Baalachandran (2020) developed a desktop based library management system where .Net technology and C# were used for the complete development of the front-end and the structured query language (SQL) was employed as the database. The system created a restriction mode for the unauthorized users from accessing all the existing materials in the database while the authorized users are allowed to access all the available materials.

Pang (2022) developed a library management system based on data mining technology and clustering algorithm and made use of Weka for library data. It takes not more than 5.5 seconds for a larger amount of data to be processed by the system with the help of the hybrid clustering algorithm that was adopted in the development. PAM and Clarance algorithms were also used in the system and these two algorithms are restricted to a number of data that the system can process. Also, data mining process needs constant modification and improvement because of its non-static nature and reciprocating process.

Chughtai, Malik, Raza and saleem (2022), used hyperledger fabric to develop a system, and the system was titled as towards blockchain enabled integrated library management system. A systematic review was adopted for the study together with the so called blockchain framework (hyperledger fabric) to prevent the security challenges in the integrated library management system such as denial of service attack, cyber-attacks, viruses and data tampering. The

system was the first system that based on blockchain and it ensure transparency of the library activities. One of the drawbacks of the system was that, it mainly addresses the security feature of the library management system while less concern about the usability, granularity and user friendly user interface.

Tsega W. (2020) used a research approach known as case study to design a web-based library management system, MySQL database, java programming language, hypertext preprocessor (PHP), hypertext markup language as the design parameters. The system enables the library users to have unlimited access to electronic books at a point I n time, the identified gap in this system was it addresses the conversion of analog formats of records to digital format but it was unable to convert multimedia documents.

Abdullah (2021) automated a secondary school library and named this system a web-based library management system, and the required information was gathered by the author through systematic literature review, on-site visitation and brainstorming. The system was developed by using interDEV as the web application tool, Microsoft SQL server 7 for the database, Microsoft 2000 for the operating system and internet information server for the web server. The operation of the system works in consortium and it enables the downloading of bibliographic records and sharing of information among the consortium members is allowed. The shortcoming of this system is that the consortium features was limited to only four schools.

A library system based on internet of things technology was developed by (Zhuang, 2021), the application of internet of things (IoT) in library management system contributes to effective optimization of personalized service system and it comes to improve the efficient sharing of information resources. The system has a WeChat message services and automatic answering services which enhances

the interaction between the users and the librarian in order to meet the required services by the users timely. The system highly banked on internet for its proper operations, and the internet may not be available or it can be fluctuating sometimes.

Lin, Zhang and wang (2022) adopted digital library text classification and word vector methods to develop a digital library information integration system based on deep learning and big data. In this system, convolutional neural network in the deep learning model was used for the extraction of the essential features of text information. These methods improve the intelligence of the intra digital library business and efficiency of the information services in the digital library. The use of vector model leads to high dimensionality of text feature vectors and the consequent data sparse phenomenon and the models also ignores the semantic information in the text.

Waterfall model was used for the implementation of electronic library management system together with PHP, HTML, CSS and JavaScript language and MySQL as database. The electronic system allows the library users to download books in pdf format unlike some systems that are providing read only materials, but the system left the circulation services untouched and this is also one of the key services in the library management system (Keshari, P and Maurya 2022).

Hossan (2022) designed a library management system by adopting JavaScript and bootstrap framework for the user interface design while PHP was employed for the backend of the system, MySQL for the database and unified modeling language diagram for the visualization of the project. The system is highly secured because of its high level of authentication, but there are some missing

functionalities such as direct borrowing of library materials because the system is still on prototype stage and the system is still under development.

Eke and Salihu,(2021) worked on developing a mobile based application for library management system for improving the delivery of services. The type of application developed for the system was native mobile application; the system is fast in operation and it can easily interact with device utilities. Android studio, HTML, PHP are the technologies used for the system. The shortcoming of the employed native form of application that was it is very expensive and it is difficult to maintain. The application also lacks the easy capturing of the library materials through barcode or other technologies. Babatope, (2022) worked on an integrated library management system using agile method for emphasizing the incremental delivery and team collaboration, the system enhanced the communication interfaces for delivery of mail and notifications to the users; this system has no limitation of the number of users in every modules and the database is unlimited.

In the year 2020, another android application for library management system was developed by (Chanda, 2020) and the system was titled usefulness of android application in library management system; the application was developed by the adoption of android studio which consists of extensible mark-up language and java language. Radio frequency identification (RFID) was also used in this application and it enables automatic circulation, detection of theft and verification of stock, but the usability of the system is limited to the smartphones users.

Xiao, (2022) worked on application of digital information technology in book classification and quick search in university libraries using a text classification algorithm and method of digital information technology for the analysis and research. The study used the TF-IDF (term frequency- inverse document frequency) weight formula for the evaluation of importance of a word in a

context and the cosine distance was used for the evaluation of two words vectors. The strength of the system is that materials can be found within five seconds with the adopted methods. The system is limited to eight categories and 2000 text data sample and this is one of the shortcomings of the system.

Luca and Fallucchi, (2021) worked on algorithm for cataloguing a book using Dewey decimal classification and library of congress classification (LCC) based on string matching and machine learning based systems for the automatic text classification. The adopted algorithms work perfectly for when inserting a new record and as well during the searching operations performed by a user. The system may encounter some issues while searching the catalogue where the same name of author is registered in the system in different ways. Innovation of management in the library using the bibliomatric analysis, scopus for the database, and the system was developed to focus on quantitative calculation of the co-occurrence of the keywords, not on qualitative calculation (Philosophy and Harsanto, 2021).

Su and Chen, (2022) developed an intelligent information service system based on virtual reality and eye movement technology; the technologies that contributed to the virtual reality that was used in the study are simultaneous image processor, human to machine interaction, network function, digital technology and simulation. The system enables the librarian to keep track of all the book transactions effectively. Philosophy and Nwachi, (2021) implemented resource description and access (RDA) in cataloguing and classification through the study of various materials from journals, texts and the internet approach. The study provides a quality catalogue records for their library resources for easy scanning and retrieval of library resources by the users. The drawback of the system are the arrangement was done via content type and this leads to problems when cataloguing multi characteristics electronic resources by the

users, and the bibliographic relationships are not well discussed in this study and the web is all about interconnected information networks.

CHAPTER THREE

METHODOLOGY

3.1 Research Approach

Systematic observation and research approaches were used for this study. With the observation approach, one to one interaction and discussion was put in place to inquire about the existing library management system in the institution and how its functionalities (functional and non-functional requirements) are being operating. For the research approach, many journals related to this study were consulted in order to gain more experience on different efforts and innovation that have been added to the digital library management system, and alongside to detect the shortcomings or drawbacks of the existing systems.

3.2 Development of a responsive web based application

All users intend or require a web application that will be platform independent, that is an application that will adapt itself to different platform, devices and screen sizes, and as well the system that will not block the user from accessing the website irrespective of the users device. Bootstrap 5 together with cascading style sheets (CSS) features such as flexible grids and layouts, image and efficient use of cascading style sheets media queries will be adopted for establishing this responsive web based application, so that as the users migrate from their laptop to Ipad the application will shift to accommodate image size, resolution and scripting abilities automatically.

3.2.1 Adoption of Bootstrap for responsive website

The correct tags for meta will be specified, detailing meta name, content, device's width and initial scale. For the responsive Navbar of the website, the position of the Navbar in the container will be specified; for a sticky Navbar attribute fixed top or bottom will be used, and here the sizes of the Navbar can be chosen to be small, medium or large.

3.2.2 Adoption of Cascading Style Sheets for responsive website

Cascading style sheets (CSS) is majorly used for designing or styling web pages and more also it is essential for building responsive websites with the proper assignment of the properties, attributes and selectors in cascading style sheet. The use of relative units such as rem for the font size greatly contributes to the responsiveness of different text in the content of a website.

Instead of using fixed sizes, width and height properties will be used as recommended for obtaining a responsive website, whereby maximum or minimum value can be specified. Making use of grids fluid and fluid images are another key properties that enable the column of the websites to be adapted to the width in accordance with the size of the screen.

Media queries help to ease the accessibility of a website on different devices like tablet, mobile, or desktop base on responsiveness. The media queries are of two types which are minimum width property and maximum width property which refer to the starting point of the size of window and the end point of the size of the window respectively. This media queries will be adopted to specify for the small devices (landscape phones), medium devices (tablets), large devices (desktops), and extra-large devices (large desktops).

3.3 Creation of automatic question generator

JavaScript will be adopted for the generation of automatic questions by setting up the structure of the programme, the functions in the programme includes the function that will store the questions, function that will display the questions, function that will store the result and lastly a function that will monitor the submit button. The programme will find the chosen answer for every question, if the answer is wrong or correct it will respond accordingly and finally show the number of correct answers out of the total.

3.4 Generation of Notification through E-mail

A JavaScript library known as simple mail transfer protocol (SMTP) which is basically used for sending emails and it is for outgoing mails alone. Correct simple mail transfer protocol server is needed to be provided after the client's email has been set up, and Gmail configuration is required for the effective use of simple mail transfer protocol (SMTP).

3.5 Evaluation of the System using Selenium testing tool

Selenium is one of the most suitable tools that help in automating testing software and it is mainly adopted for performing functional testing of web applications. It consists of selenium IDE where scripts together with record and playback interactions from the browsers can be quickly created; there is selenium grid where multiple configurations and machines can be tested at the same time, also it includes selenium web driver and bindings which help in driving the browser for testing.

3.6 Architecture of the System

3.6.1 Flowchart

Flowchart is the graphical or pictorial representation of the processes involve in carrying out a specific task. It includes some special symbols that describe the

form of activity perform in every stage; some of the symbols are start, stop, process, input and output *etcetera.* The flowchart below depicts or shows the processes that must be put in place before an authorized user in the library management system can be eligible to borrow library materials. The user will have to firstly be an authorized user of the library to open the borrowers log, then the user will be added to the borrowers log and finally have access to the required materials if available in the library database. The e-mail will be sent to the user for over due date notification, the process stops immediately after the books have been returned. The below flowchart in figure 3.0 depict the processes involve in borrowing books in the library.

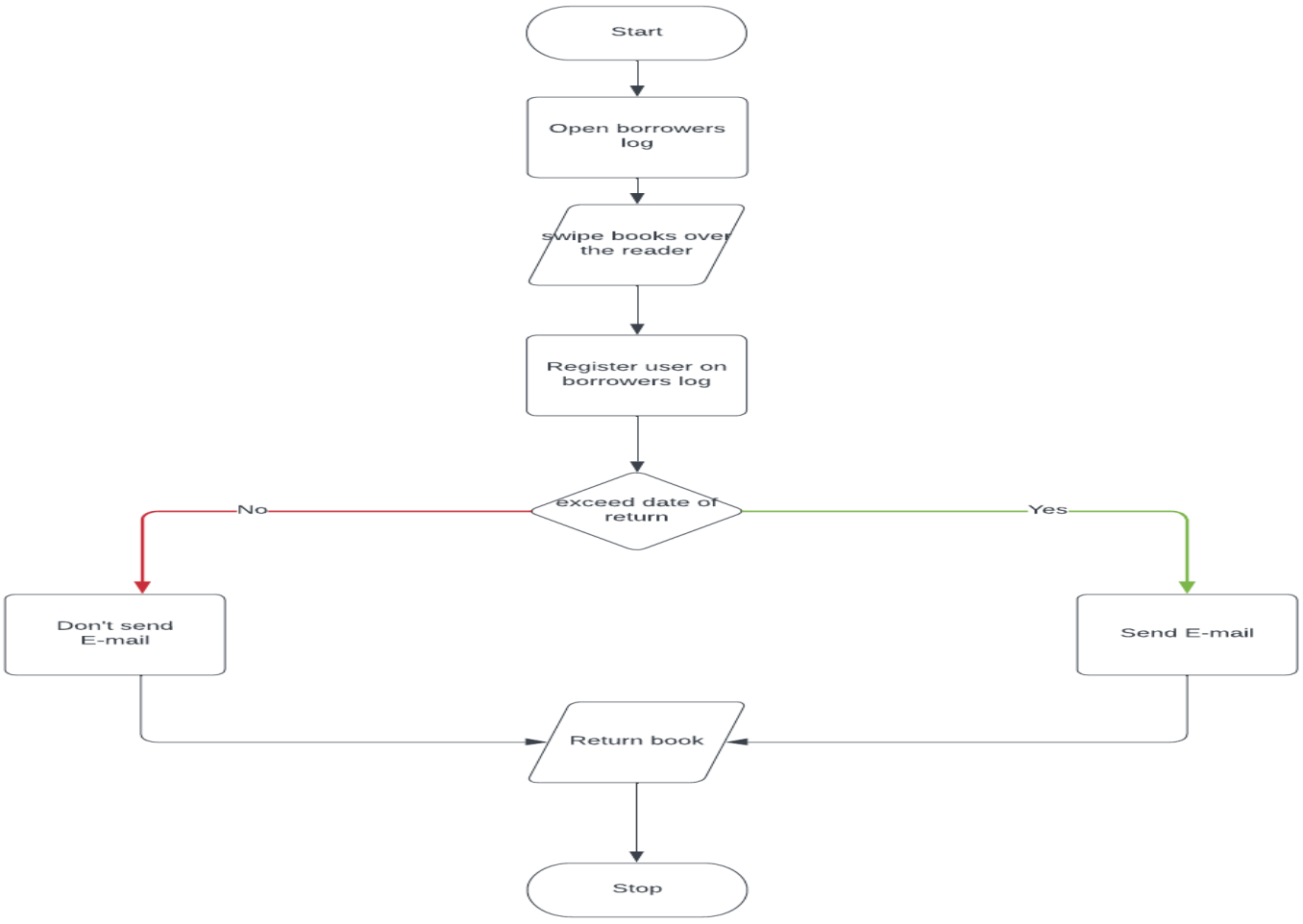

Figure 3.0: Flowchart of book borrowing in the Library Management System

3.6.2 Use Case Diagram

Use case diagram describes the main functions to be offered by a system, and it gives the illustration of the functional requirements that the system is expected to perform. It is represented with a rectangle known as container which bounds all actions that are to be performed by a system together, and it also consists of several ovals that represent the names of the functions to be offered. Moreover, it is a diagrammatic representation of the relations between the actors and users of a system (Aquino, 2020). The use case diagram in figure 3.1 below depicts the functional requirements of the library management system. It indicates major functions that the librarian can perform such as addition of new publications, addition of student, removal of student, issuing of books, likewise the functions that users are allowed to perform like searching for books, issuing or returning book issued, penalty report and changing of password *etcetera.*

Figure 3.1: Use case diagram for the functional requirements of library management system.

3.6.3 Sequence Diagram

A sequence diagram which can also be referred to as the system sequence diagram that shows process interactions that are arranged in time sequence.

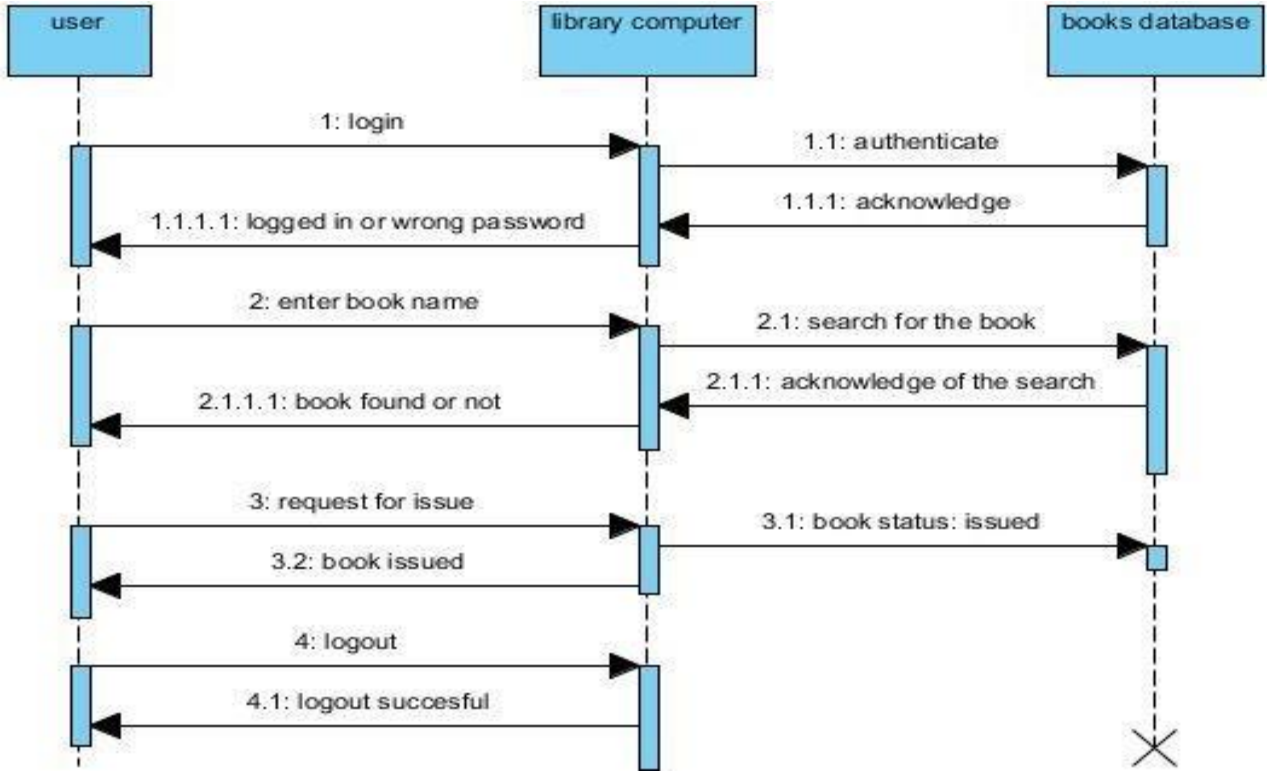

Figure 3.2: Sequence diagram for library system

3.7 Implementation Requirements

This section discusses the requirements that are needed for the proper implementation of the intended system; such requirements include functional requirement, non-functional requirement, software and hardware requirement

3.7.1 Functional Requirement

Functional requirements are the expected inputs by the system, the expected outputs that must be produced by the system and the correlation between these inputs and outputs. It is the requirement that describes what a system must do and it is usually focuses on user requirement. Below are some of the functional requirements of this intended system:

I. The system should allow the librarian to perform addition and removal of members.
II. Users should be allowed to search the catalogue.
III. The system should allow the librarian to manage and add new books.
IV. The user and the librarian should be notified by the system about the overdue books.

3.7.2 Non-Functional requirement

These are requirements that focus on how the system should work and the constraints under which the system should operate and give the description of the general properties of the system. It mainly emphasizes on user expectation and they are usually added by the developers. Some of the non-functional requirements are shown in figure 3.3 and discuss below:

I. Maintainability: Addition of new features, changing or improving of the existing features of the system should be as simple as possible and it should be maintainable.

II. Availability: This emphasizes on the operating hours of the system, it states that for the whole operating hours of the library the system should be available and the requests of the users should be responded to within a couple of seconds.

III. Accuracy: Another important non-functional requirement is accuracy, which focuses on the correctness, consistency and reliability of the

information stored about the books and the calculated fines in the library management system.

IV. **Usability:** This is concerned with the ease of accessing the user interface of the system and stated that the system should be understandable to every user without requiring any further or special training.

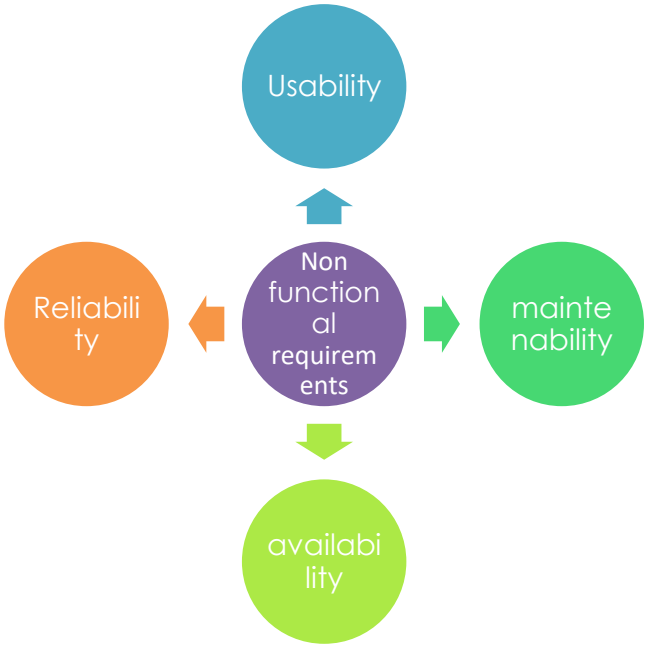

Figure 3.3: Examples of Non Functional Requirements

3.7.3 Software Requirement

This section discusses the soft wares that are required to run this proposed system, and the requirements are listed as thus:

1. A server running windows server.
2. An integrated development environment (IDE) such as visual-code studio.
3. Front-end languages and frameworks such as JavaScript, and bootstrap.
4. Relational database management system such as MySQL.

3.7 Expected Contribution to Knowledge

Library plays important roles in education and research through the circulation of information and readable materials to the university students and lecturers, and this study is expected to enhance the library usages and information access through internet facilities. Moreover, this system is expected to improve the library activities such as registering of library users, interlibrary loan, charging and discharging of library materials *etcetera.*

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