DEVELOPMENT OF A LIBRARY CIRCULATION SYSTEM FOR THE IBRAHIM BADAMASI BABANGIDA LIBRARY, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA USING JAVA AND MYSQL

Abduldayan, Fatimah Jibril[1], Ibrahim, Muhammed Rabiu[2], Jibril, Attahiru Alhassan (Ph.D)[3] and Fasola P. Abifarin (Ph.D)[4]

[1,2,4]Department of Library and Information Technology,
School of Information and Communication Technology,
Federal University of Technology, Minna,
Niger State, Nigeria
[1]fj.dayan@futminna.edu.ng
[2]muhammed.ibrahim@st.futminna.edu.ng
[4]fp.abifarin@futminna.edu.ng
[3]University Librarian, Ibrahim Badamasi Babangida Library,
Federal University of Technology, Minna,
Niger State, Nigeria
[3]j.alhassan@futminna.edu.ng

Abstract

This study is focused on the design and implementation of a monitoring-based library circulation system: a case study of Ibrahim Badamasi Babangida Library (IBBL), Federal University of Technology Minna.It has been observed that library users borrow books and fail to return them thereby leading to loss of such library materials which might be sometimes expensive and almost impossible to replace. There is therefore the need for developing an automated monitoring-based library circulation system that will remind library users of due date for return of books and also award fines as appropriate. The study adopted the system analysis and design method and used Java programming language and MySQL to develop the front-end and back-end of the system respectively. The study recommended that the university library management should encourage the use of the monitoring-based system for improved circulation system and enhanced service delivery.

Keywords: Circulation System, Library System, Information System, Database Management System.

Introduction

Information Technology (IT) has brought about fundamental and notable changes in all facets of life and has eased the techniques or methods by which activities across these facets are being carried out. These impacts of IT across all fields of life are mostly centred on its importance such as speed, accuracy, persevering application, versatility, flexibility and robust data/information storage (Tabusum,Saleem & Batcha, 2013). Library as one of these fields of life is challenged with the responsibility of providing the right information to its clients/users and in order to achieve this, there is need for circulation section in the library among other sections, to handle the organisation of information resources so as to aid easy retrieval and dissemination.

Circulation in library involves all routine operations associated with the management of information resources and library clientele, such as registering new books and users by recording relevant and necessary data, charging and discharging of library books (Tesendic, 2012).Circulation process in the library has been given great attention during the last decade and the reason for the general interest in circulation process is apparent. Due to the increasing rate of enrolment in academic libraries, information literacy and the library consciousness generally, the issue of circulation of booksin libraries has always been a grievous operation and

the process has vastly increased in recent years. In order to solve or reduce the grievous nature of the circulation process to a minimal level, there is a great need for the application of information technology, hence, automation of the conventional circulation system.

Library circulation system or library circulation management system is a database management system program used in a library for effective and efficient book circulation management such as addition of books, users, issue dates, due date, return date, fine payment, etc. (Kawthar, Joshua & Oladayo, 2015). The automation of library circulation system is not a new but rather an ongoing research area. Some researchers have worked on automation of library circulation but presently, the circulation system of Ibrahim Badamasi Babangida library, Federal University of Technology, Minna (IBBL, FUTMinna) is not yet automated. Among the available researches are: "Automated Circulation System Using Visual Basic 6.0" by Anuradha (2000) and Kawthar et al. (2015) on "Development of a Circulation System: Case Study of T. Y. Danjuma Library of the Ajayi Crowther University".

For a circulation system to be considered a good system, it should save the time of the borrowers and staff, reduce costs, speed up charging and discharging of books, provide opportunity for professional work by the circulation librarian, have the ability to store all necessary information, prevent and eliminate data redundancy and duplication of effort and solve security issues which can lead to loss of books.

The developed system should be able to monitor the circulation activities including notification of borrowers when the time is due for them to return the borrowed book(s). The system is to be developed using Object Oriented Programming (OOP) and Client/Server architecture. By using this system, the library circulation management will become more effective and will ease the processes involved in handling book circulation with its reliable sub-systems.

Review of Related Literature

Anuradha (2000) proposed an automated library circulation system. The system was designed using Visual Basic 6.0 as its front end (Graphical User Interface) while the database was designed using Oracle 7.3 as its back end. The system was designed and developed to meet up the requirements of a medium sized library. In the work, provision was made to search for available books using book number but not with title, subject or author. The system was designed to cater for the major circulation activities but did not cover user notification for due date and was an offline (desktop based) system i.e. user must come into the library to carry out any transaction.

Adekanye (2011) proposed a system for the computerisation of the Fatiu Ademola Akesode Library, Lagos State University. In the work, the author suggested that the library required a system that is outside the scope of the card catalogue that would provide multiple accesses to the complete information resources. The system was expected to be unified (integrated) in two ways – by holding records of all forms of publications in a single database, and via coalition (combination) of operational records (Adekanye, 2011). The desired system was required to provide for circulation operations among nine other listed functions. The shortcomings associated with the work were in the implementation process due to the number of complex goals set up for the system to achieve and the complexity of the tools used. In addition, TINLIB is observed not appropriate for such system (Kawthar et al., 2015).

Kawthar *et al.* (2015) proposed a system for the T. Y. Danjuma Library, Ajayi Crowther University. The system was designed using VB.Net as its front end and MySql Server 6.0 as back end. The system was to take care of all the activities of the circulation system carried out

manually at the T. Y. Danjuma Library of the Ajayi Crowther University. The system covered the major circulation activities including notifying users about books due for return but provision was not made for searching for registered users and available books until a user wants to borrow book that his/her ID will be verified to determine if he/she is registered in the database. In addition, there is no means of remote user interaction with the system, meaning the users must come into the library to carry out any transaction.

In filling the identified gaps in the previous studies reviewed, this study adds as part of the features/functionalities of the proposed system, the ability for registered library users to remotely request to borrow book. In addition, circulation staff and library users will be able to search for available books either by author, title or subject. The system will also be able to automatically generate circulation statistics which will be accessible to only circulation staff.

System Analysis and Design
Evaluation of Existing Manual System
At present, the circulation activities in theIBBL, FUTMinna are done manually. All users who wish to borrow books need to register at the circulation desk where they will be given the library borrowers' card (four cards for staff and two for students). Whenever a user wishes to borrow a book, he/she goes to the shelf and fetches the book, then brings it to the circulation desk where a circulation staff will attend to him/her. After making the necessary processing and verification, the staff takes the book card from the book pocket (attached to the book), stamp the book's borrower slip and book card with the date due stamp, then collects a copy of the user's library card (for student) or two copies of the card (for staff) from the borrower and file the user's library card and the book card in order, while the borrower slip is attached to the book so as to serve as reminder to the borrower, concerning the due date. This involves documentation which sometimes, it is not easy to track overdue books.

The duration of a borrowed book from the issue date to the due date as well as the maximum number of books to borrow at a time varies among the various categories of users. The major categories are staff and students. Among the staff, there exist two categories, the teaching and non-teaching staff, while the student category makes it the third category of borrowers.A student is allowed to borrow not more than two (2) books at a time which lasts for maximum of two (2) weeks, a non-teaching staff is permitted to borrow four (4) books maximum, at a time which will last for not more than four (4) weeks, while a teaching staff is permitted to borrow four (4) books maximum, at a time which will last for an academic semester. Figure 1 below depicts the major activities performed at the circulation desk.
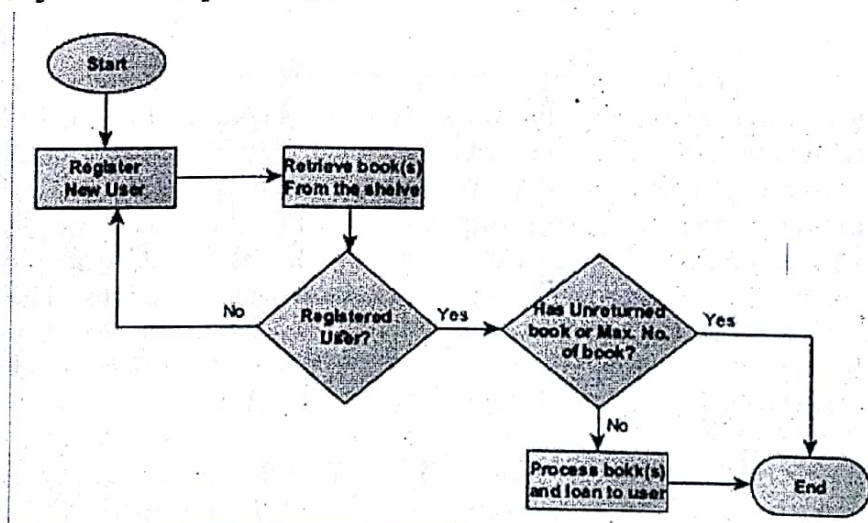

Figure 1:The Existing Manual System of Circulation in IBBL, FUTMinna.

In order to simplify these tedious tasks as well as the difficulty in tracking and managing overdue books and delinquent borrowers, there comes the need for an automated circulation system which has a lot of advantages over the existing manual system such as; reliability and validity of information, cost and benefit, time efficiency, service performance, etc.

Requirement Analysis

Requirement analysis is an in-depth study on what is to be expected from a system. The proposed system will handle all the circulation activities and as well add some supportive features in other to ease the work of the circulation librarian/circulation desk officer.

Functional Requirements

Functional requirements explain what has to be done by identifying the necessary tasks, action or activities that must be accomplished in the design. Below are the functional requirements of the proposed system.

1. Circulation staff and library users should be able to login to the system through the first page (homepage) of the system;
2. Circulation staff should be able to add new books and users, update users' and books' record and remove existing books and users from the system;
3. Circulation staff should be able to charge book to users and also discharge book from them;
4. Users should be able to remotely request to borrow book;
5. Users should be able to see the status of the books borrowed by him/her and the due date;
6. Users and circulation staff should be able to search for a particular book by either author, title or subject;
7. Circulation Staff should be able to search for registered users, borrowers or books on loan;

Non-Functional Requirements

Non-functional requirements are also known as supportive requirements. They support the functional requirements in order to make the system more convenient for the users. The non-functional requirements of the proposed system are:

1. Circulation staff and users should be able to change their password after login into the system and also get help about how to use the system;
2. The system should be able to send an automatic notification to user, both to their e-mail or mobile number, about the expiry of the due date of the book(s) borrowed by them;
3. The system should be able to calculate overdue fine and overdue notification charges;
4. The system should have a simple calculator and calendar to be used for external calculation and verification;
5. Circulation staff should be able to view statistics of the transactions performed within a period of time.

Process Flow Diagram

Unified Modelling Language (UML) is a standardised graphical language and notations for describing object-oriented systems. The UML diagram describes interaction between the system and its users as well as the activities to be performed by the users. Figure 2 and 3 below depict the user interface of the proposed system and the major user interaction with the system respectively.
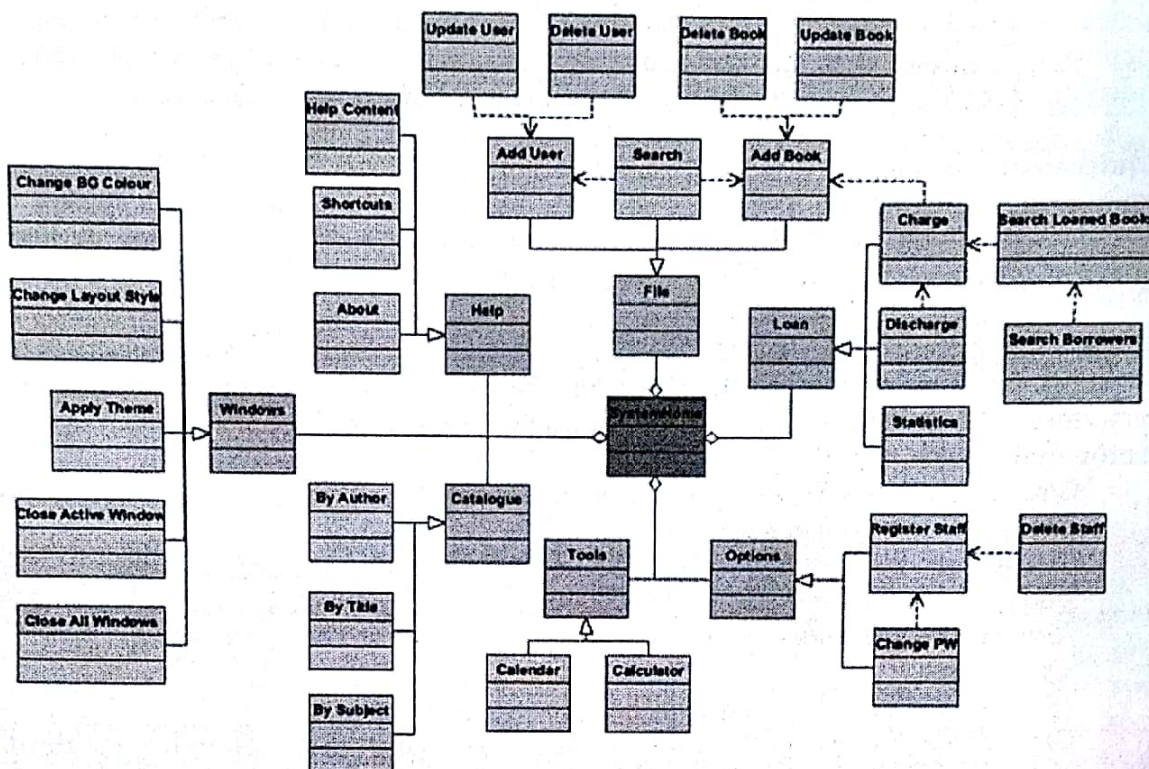
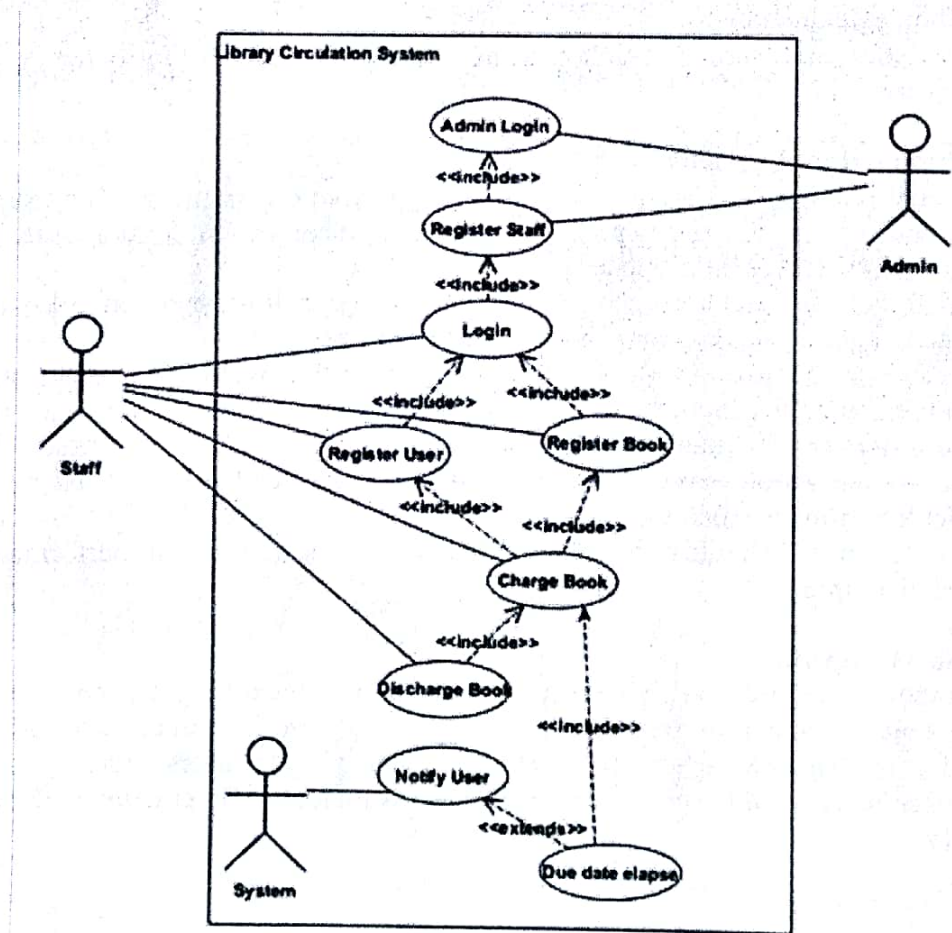**Figure 2:   Class Diagram of the Developed System's User Interface**

Figure 3:   Use Case Diagram of the Registration Process

Book Borrowing Process

If a user wants to borrow book, the circulation desk officer login to the system, clicks on charge book. The system will provide a field for the officer to enter the User ID. After entering the User ID, the system verifies the ID whether it is correct or not. If the User ID is correct and the user has not borrowed up to the maximum number of books at a time or has no overdue book with him/her, the system provides the officer with the options of either selecting a particular book by typing its bibliographic details or to search for book. Having selected the book, the officer clicks on borrow then gives the book to the user. Figure 4 and 5 below illustrates the book borrowing process using activity diagram, while figure 6 shows the class diagram of the borrowing process.
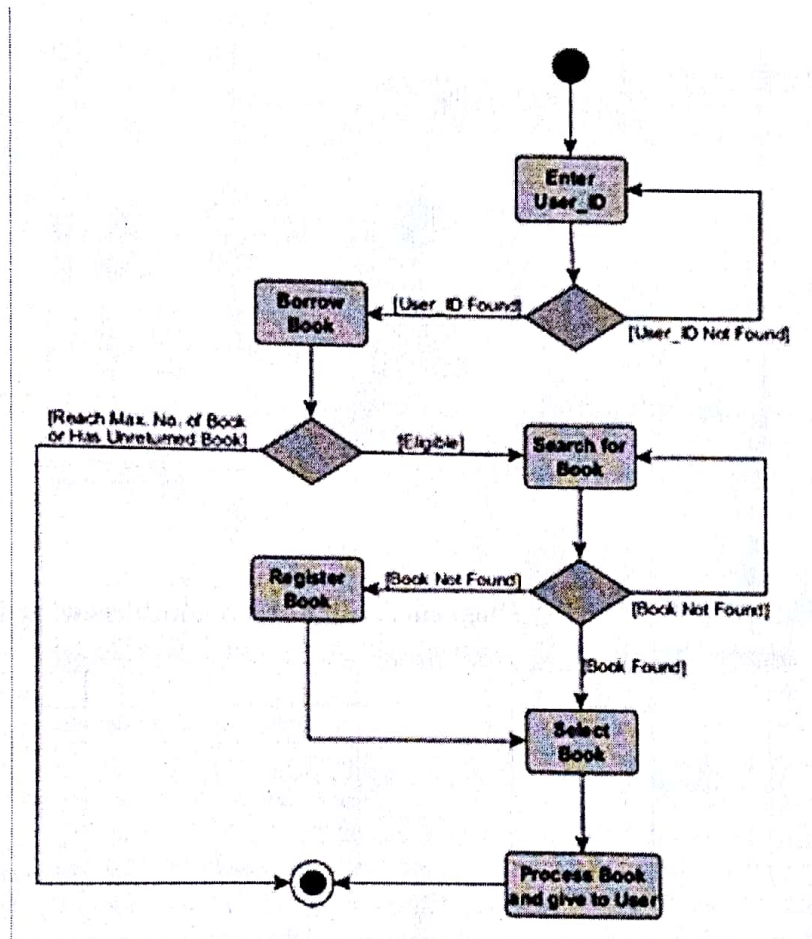
Figure 4: **Activity Diagram for Local Book Borrowing Process**

If the book is being borrowed, three (3), two (2) and one (1) day to the due date, the system automatically send notification message to the user via his/her E-mail, reminding him/her the date and time when the book will be due for return. If eventually, the user does not return the book(s) and the due date elapses, the system will start calculating the fine and as well will start sending notification to the user via his/her mobile number on daily basis, which will cost the user (for example N10 per notification) depending on the amount specified by the circulation librarian/officer. This charge is calculated together with the overdue fine.
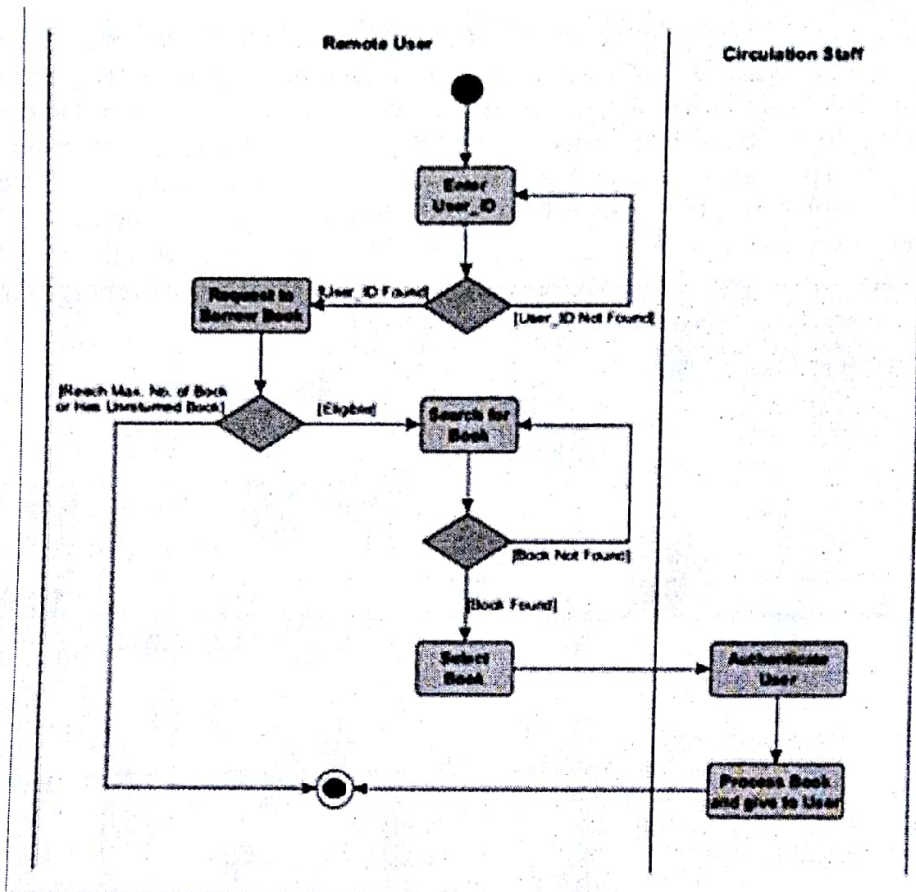
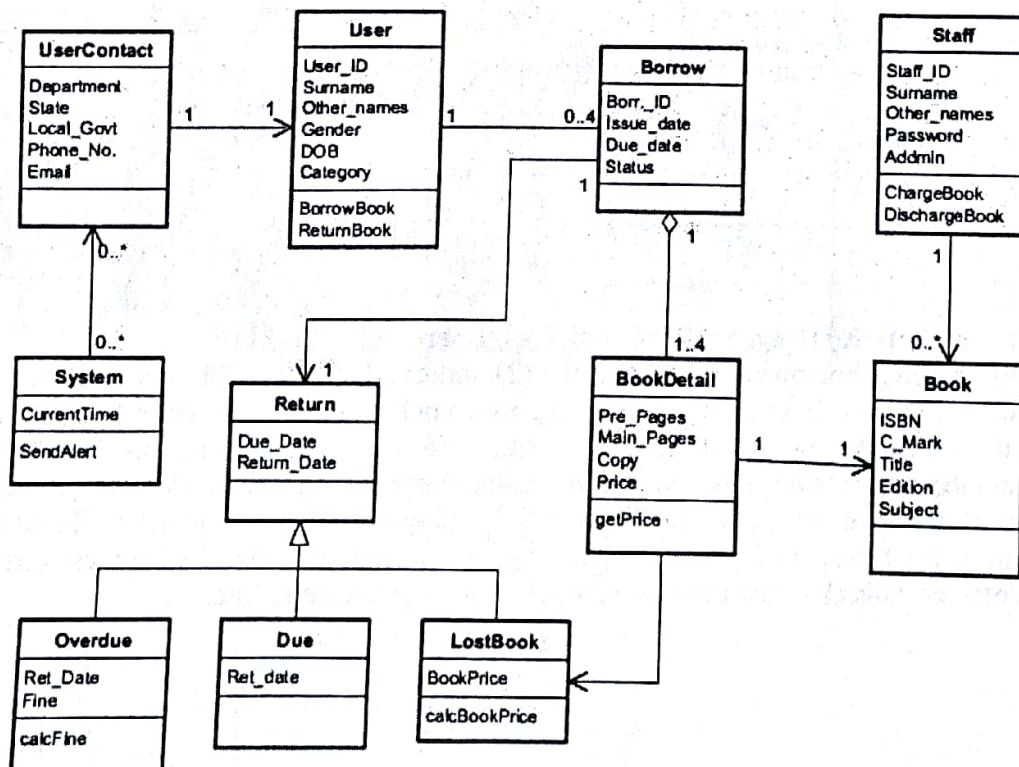**Figure 5:   Activity Diagram for Remote Book Borrowing Process**

Figure 6:   Class Diagram for Book Borrowing Process

If the user wants to return the book, whether on or before the due date or overdue, the circulation desk officer clicks on 'Loan' then clicks on 'Return'. He/she inputs the User ID then selects the book(s) which the user wants to return, then clicks on "Received". A confirmatory message will pop up asking the officer if he/she has received the book, of which the officer will need to click 'OK' if he/she is sure otherwise; he/she clicks 'Cancel'.
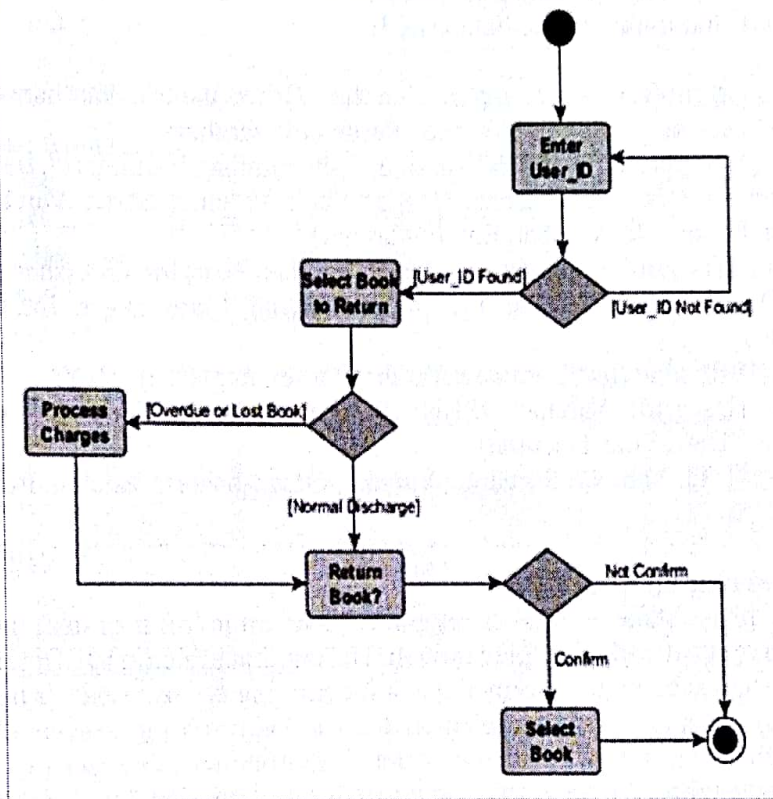

Figure 7: Activity Diagram for Book Discharging Process

Entity Relationship (ER) Diagram

Entity Relationship diagram is a diagrammatical representation showing the relationships that exist between/among entities (objects) in the database. In the proposed system, there are two main entities – Users and Books. There exists a relationship set called Borrow between these entity sets. The entity set 'User' has attributes such as User_ID, Name, Gender, Department, Date Of Birth, User_Category, etc. The 'Book' Entity set has ISBN, Class_Mark, Title, Edition, Subjet, etc. and the relationship set 'Borrow' has attribute – Borrow_ID, Date, Time, Due_Date and Fine.
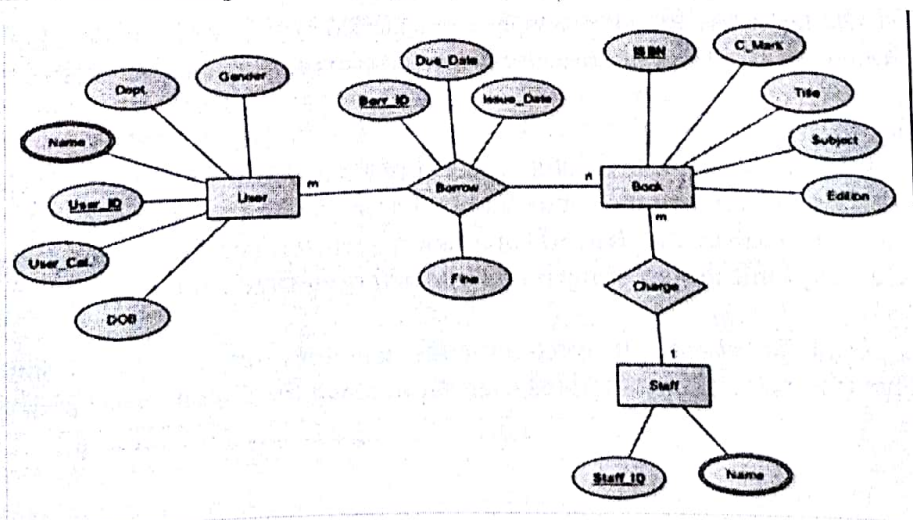

Figure 8: Entity Relationship Diagram of the Database

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System Database Schema

The data model used for this work is the relational model; and schema in terms of relational model consists of two types, relation schema and relational database schema. Relation schema delineates the structure of a relation (table) which includes the name of the relation, the columns/attributes, and the domain/data type while relational database schema is a set of related relation schemas that make up the database. Below is the relational database schema for the system;

> User (<u>User_Id</u>: Varchar, Surname: Varchar, Other_names: Varchar, Gender: Varchar, DOB: Date, User_Category: Varchar, Password: Varchar)
>
> Book (<u>ISBN</u>: Varchar, C_Mark: Varchar, Title: Varchar, Edition: Int, Subject: Varchar)
>
> UserContact (User_Id: Varchar, Department: Varchar, State: Varchar, Local_Govt: Varchar, Phone_No: Varchar, Email: Varchar)
>
> Publication Detail (ISBN: Varchar, Place: Varchar, Year: Int, Publisher: Varchar)
>
> Book Detail (ISBN: Varchar, Pre_pages: Varchar, Main_pages: Int, Copy: Int, Price: Decimal)
>
> Author (ISBN: Varchar, Surname: Varchar, Other_names: Varchar)
>
> Borrow (<u>User_Id</u>: Varchar, <u>ISBN</u>: Varchar, <u>Borr_Id</u>: Varchar, Issue_date: Date, Due_date: Date, Fine: Decimal)
>
> Staff (<u>Staff_Id</u>: Varchar, Surname: Varchar, Other_names: Varchar, Password: Varchar, Admin: Int)

System Implementation and Testing

An imperative phase/stage in the development life cycle of a system is the successful implementation of an already designed system. During the implementation phase of a system, the designed system is being transformed into a functioning system which is being evaluated or tested and finally accepted for use. Implementation includes writing of system's program code, testing/evaluating and installation into the intended environment to be used (Valacich, George & Hoffer, 2012).It describes the programming language, tools used and the constituents that make up the system. The system comprises of the desktop version and web-based version. The desktop version is for use within the library by the Circulation Officers, while the web-base version is for remote access by the users of the library. Both are linked to a single database. The system front-end was designed using Java programming language, while the database was designed using My Structured Query Language (MySQL) database management.

Choice of Programming Languages

Java programming language was chosen for developing the system's Graphical User Interface (GUI) and the functionalities of the system because it ensures system security and robustness, while MySQL Database Management System (DBMS) was used to develop the system's database because it allows for multi-user access as well as concurrent data access.

System Security

Security is very important to this system especially when use on the Internet environment. The users of the system are grouped into three categories. At the highest level is the system administrator (who can be the Head of Circulation Section). The Circulation Desk Officers are the second group, while the last group is made up of the registered library users.

Valid User ID and password is required for authentication whenever a user wants to access the system. This is to prevent unauthorised users from using the system or accessing the system's data.

Development Environment

The following describes the hardware and software requirement for the system development

process. Suitable system development environment has to be established to ensure smooth implementation process.

Hardware Requirement

Table 1 describes the hardware requirements of the Monitoring-Based Library Circulation System.

Table 1: Monitoring-Based Library Circulation System Hardware Requirements

Hardware	Description
Processor	Intel Centrino 1.6 Ghz processor or higher
Memory	At least 512MB,
Hard disk space	At least 50MB
Others	Internet access

Software Requirement

Table 2 describes the software requirements of the Monitoring-Based Library Circulation System.

Table 2: Monitoring-Based Library Circulation System Software Requirements

Software	Description
Operating System	Windows
System Server	Wamp5 1.7.2 or higher
Relational DBMS	MySQL 5.0.45
Programming Language	Java
Database Connector	Mysql-connector-java-5.1.4.1

System Testing

System testing is a generic term that covers several types of test. System testing can be achieved with or without executing the system's program codes and can equally be done using automated or manual approach. From this overview of testing, system testing can be categorised into: manual – inspection, walkthrough and desk checking, and automated – syntax checking, unit testing, stub testing, integrated testing and system testing (Valacich et al., 2012).

Software Testing/Verification

At this stage of the system development, the system is realized as a set of programs or program units. The various units of the system are tested to verify that they perform their expected functionality. This exercise proves the correction of the software application. The automated approaches mentioned in the previous section, were used to test for the correctness of the software. In addition to debugging to ensure that the system is error free, it was also tested for data integrity and format, to check for data validation, to make sure the system accepts only the set data format it is designed to accept and to report error when wrong data is keyed in. Another approach used in testing the correctness of this system was the Participant Observation Testing (POT).

Conclusion

The proposed system performs the manual circulation activities carried out in the library, more efficiently and effectively. The system in addition to the manual routine circulation activities provides additional functionalities such as processing and printing circulation statistics, searching or browsing the holdings of the library, sending overdue alert, calculating overdue fine and preventing system circulation malpractices. The system will make the job of circulation desk officers easier and faster thereby enhancing effective and efficient book circulation process.

Recommendations

Based on the findings of this study, the following recommendations were suggested:

1.   University library management of the IBBL FUT Minna should encourage the use of the monitoring-based system for improved circulation system and enhanced service delivery.

2.   For further study, improvement can be made such that library users can register remotely without security breach.

3.   Aside bibliographic details of book, users can also be able to access book abstract in order to know the relevance of the book before making request to borrow or reserve the book.

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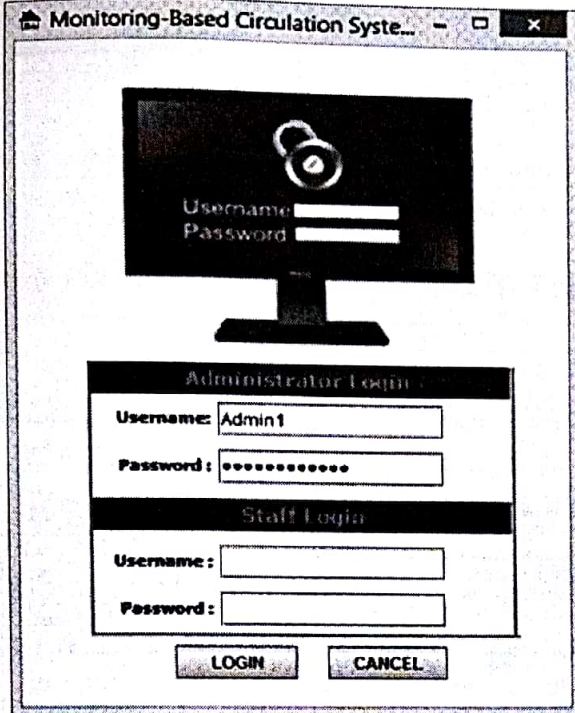
System Interface

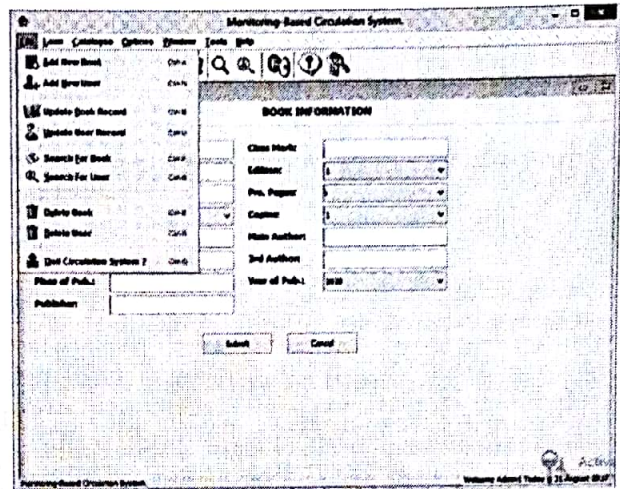**Figure 9: Snapshot of System Login page**

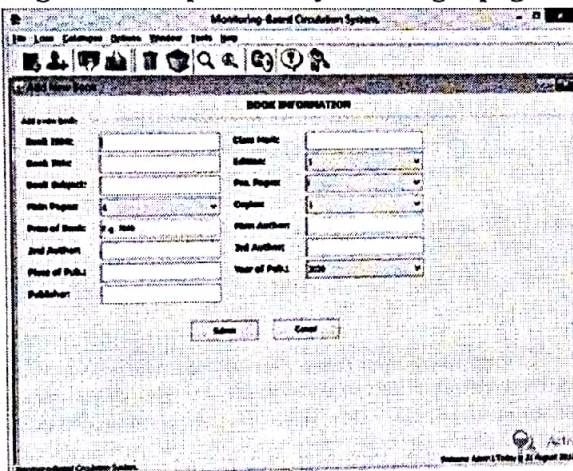**Figure 11: Snapshot of System Book Registration Interface**

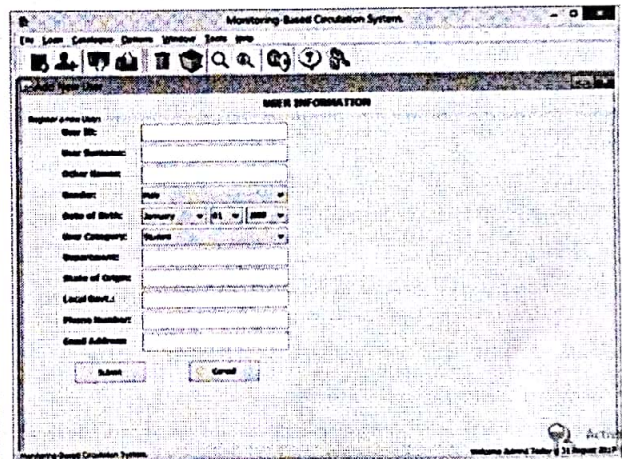**Figure 10: Snapshot of System Drop down menu**

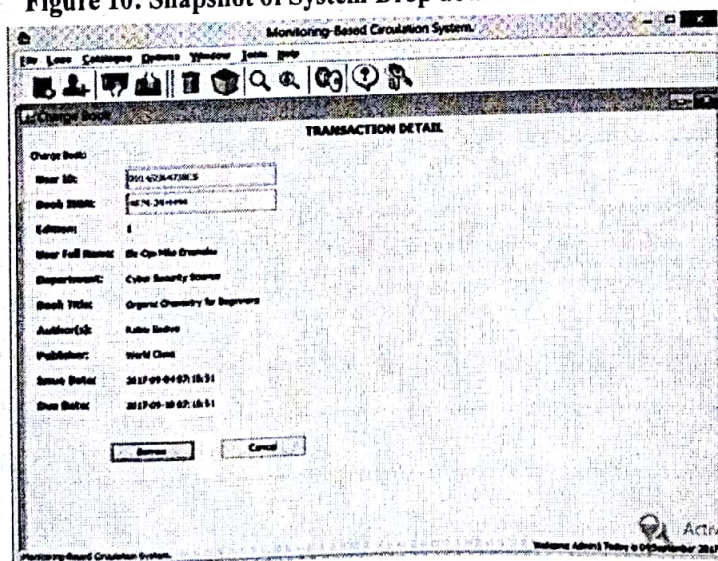**Figure 12: Snapshot of System User Registration Interface**

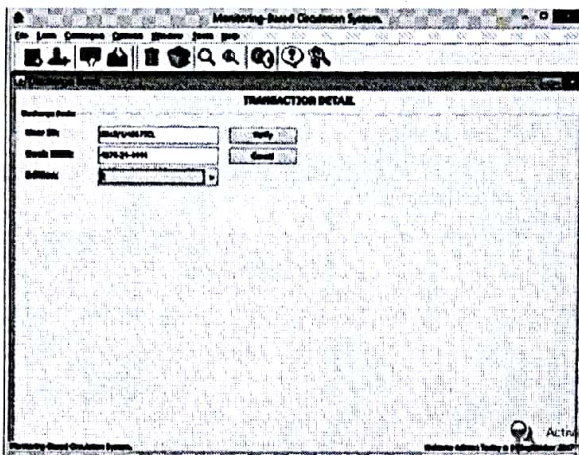**Figure 13b: Snapshot of System Book Charging Interface**

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Figure 14a: Snapshot of System BookDischarging Interface (Verification)
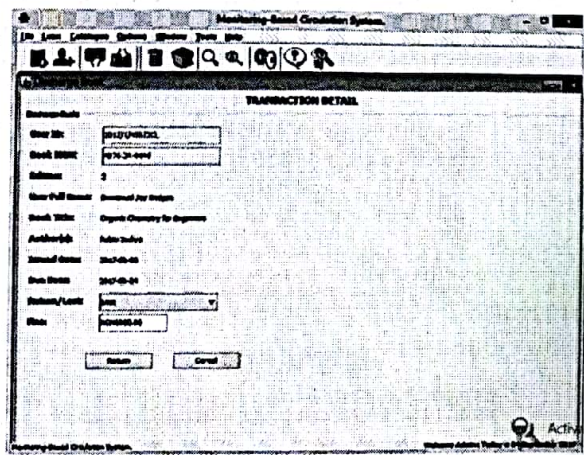
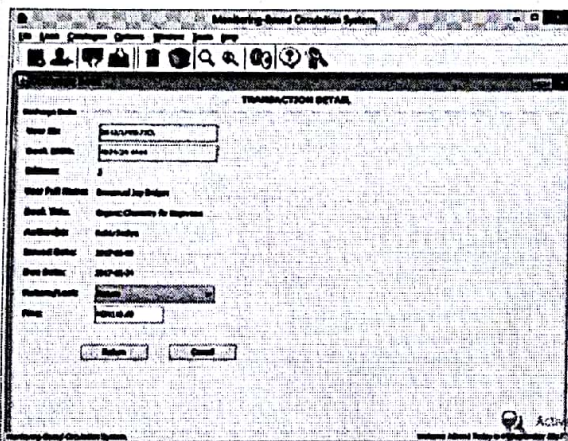Figure 14c: Snapshot of System Book Discharging Interface (Lost Book)
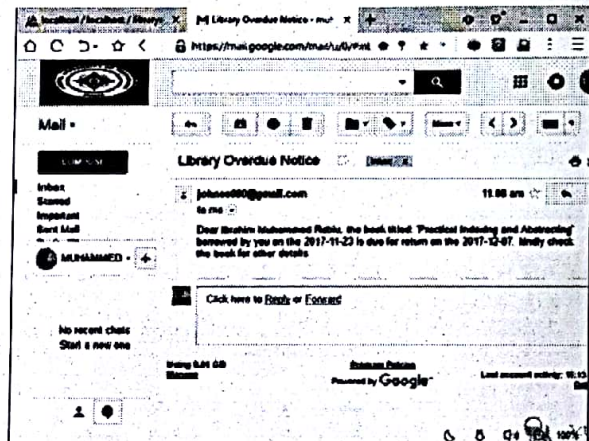

Figure 14b: Snapshot of System Book Discharging Interface (Returned Book)

Figure 15: Snapshot of System Notification sent to user