

An E-library System Integrated with Bookshelf and Recommendation Components

Folasade Olubusola Isinkaye*¹, Tomiwa John Fred-Yusuff²

^{1,2}*Department of Computer Science, Ekiti State University, Ado-Ekiti, Nigeria*

*E-mail : folasade.isinkaye@eksu.edu.ng*¹, fredyusuffrainbow@gmail.com²*

**Corresponding author*

Abstract - Apparently, most students in Nigeria are facing challenges as regards to the lack of portability, stress, time wastage and inadequate resources in terms of accessing the school libraries, as well as the inefficiency of the existing e-library, leading to the reduction in the number of students that do access the libraries. Research has shown that most students no longer believe in the physical libraries and have developed interest in electronic resources. Hence, an e-library system enhanced with book recommendation component could serve as a solution to these problems. Several researchers have repeatedly attempted to develop various solutions to this problem using various methodologies and approaches in order to provide a digital library that could address the aforementioned problems. In this work, an e-library system integrated with recommendation component was designed and implemented to help students locate relevant books. Also, an additional feature which adds books to the shelf for future reference was included to enhance accessibility and efficiency of the system. The web application was implemented on a live server (Namecheap) which is one of the most effective live servers in Nigeria. Furthermore, the system was evaluated with one hundred and fourteen (114) students, and the results of the evaluation carried out on the system emphasized its usefulness in terms user friendliness (77%), user experience (86%), interface appearance (75%), system loading speed (82%), platform compatibility (78%), recommendation accuracy (80%) and recommendation reliability (84%). Therefore, the system could be used to solve students' problems with regards to the challenges faced with the use of physical and conventional e-libraries.

Keywords – Bookshelf, E-library, Content-based filtering, Recommendation component

1. INTRODUCTION

Libraries are indispensable components of any institution of learning, and they supply both educational and other information resources. The procedure of organizing the library activities manually is encumbered with a waste of time and needless stress. As a result of the above-mentioned problems, an automated approach to handling the activities of a library that makes effective use of current library resources for the advantage of users was proposed by [1]. Robel et al. [2] observed that with the way the number of students is increasing in higher institutions of learning today, maintaining the traditional library system will be too complex, time-wasting, and resource-intensive, which can reduce students' visits to the library [3]. Eke and Salihu [4] considered the manual library system inefficient, prone to delays, errors, and requiring the physical and mental efforts of the library staff to manage. They added other challenges such as unnecessary delays in library transactions, which include issuing or returning of books, documentation and misfiling of library materials, inadequate space to

accommodate the ever-increasing library collections, damage of library materials due to limited copies and the inability to manage library processes remotely. However, with the introduction and widespread usage of computers, expert systems, and artificial intelligence, libraries are currently converting their information handling activities into digital format. Also, the advances in digital technologies and the interoperability of systems now permit cross-sectorial participation and extraction of metadata, while the internet offers the delivery tool. Institutions are also creating digital items, and converting existing items into digital format [5,6] to meet the demands of the present period. Alokuk and Al-Amri [7] described the major purpose of an e-library system as providing access to different resources through a single window in an institution remotely. Singeh et al. [8] emphasized the need to find means of making e-library more usable and sustainable to the user community.

Recently, libraries are introducing modern scientific and technological techniques to improve the experience of their users [9]. For example, an existing university library management system was improved by introducing radio frequency identification technology (RFID) and the internet of things (IoT). The system uses RFID tags, RFID tag readers, ESP8266, and a back-end database to store the required content to automate the activities of returning books with minimum human intervention [10]. The work of Du et al. [11] similarly proposed activity recognition in a smart library by using RFID to trace the reader's trajectory, recognize which book is picked up, and detect the book's misplacement. Also, artificial intelligence (AI) has now found application in different units of the library system to improve the service delivery of librarians. They include expert systems for reference services, book-reading and shelf-reading robots, and virtual reality for immersive learning, among others [12]. In the work of Daimari et al. [13], diverse machine learning models, such as Random Forest, support vector machine (SVM), and artificial neural networks (ANN) were used to predict the possible availability of students' preferred books in the library. Kumar [14] developed an efficient robot that used a laser pointer to easily locate books in the library. The robot points out a direction to the user using the laser pointer, and the user is able to comprehend the guidance of the robot without difficulty and intuitively. Tian [15] adopted a multi-intelligent agent collaboration method which combines content-based filtering techniques and intelligent agent learning optimization to improve the performance of the library system. The system was able to match the results of traditional document retrieval, effectively filter out readers' demand for information, and reduce the time for readers to search for required information, improve reader retrieval efficiency, and realize the information push of similar users.

In this paper, we tried to incorporate a recommendation component that allows tailored recommendations of books to students in the e-library. Isinkaye et al. [16] described recommender system (RS) as a tool that assists in filtering relevant and personalized information fragment out of a large amount of dynamically generated information. Among the different domains identified where RS could be applied was in scientific libraries for finding research resources speedily. Therefore, we designed and implemented a library system with recommendation component to suggest relevant books to students. Also, an additional feature which adds books to the shelf for future reference was also included to enhance the accessibility and efficiency of the system.

2. RESEARCH METHOD

The school librarian acts as the administrator of the system, and he/she is responsible for adding information such as books and other relevant materials to the system. The admin specifies each book category, the author, the title, and sub-categories on the database. Once the admin. has added details of the books, then the JavaScript Object Notation (JSON) is used

to automatically convert the detailed information supplied by the admin into an API format. In **Figure 1**, the API is the application programming interface, which serves as an interface that enables different components of a system to connect to a database without a physical connection. The API for the e-library system was built with Flask. The database holds the details of the admin and users (students) as well as the book details and other vital information needed by the system's users as well as the book details. Whenever users (students) register on the system, they are automatically assigned unique numbers such as the matric number. When books are also uploaded to the system and are stored in the database, the books are equally given their unique numbers, and these unique numbers make each identity of the books different. Students that have already registered on the system can have access to the books on the system, as well as the ability to add books to their shelves and also get recommendations of books from the system. The e-library interface has a place where users can search for books based on their title or the author's name, as well as options for selecting the categories of books he or she prefers to read. After specifying the book description and the admin selects the "Add book" option, the description of the book and its ID are sent to the machine learning component, which is trained to understand the book details. Recommendations are generated for users using the content-based filtering techniques, specifically the TF-IDF model, which generates recommendations based on the previous interest shown in similar books by the students.

Other technologies used to build the system include Hypertext mark-up language (HTML) which was used to create the text part of the website and help to bring images into the website as well as make pages to linked together. Cascading style sheet (CSS), it was used to make the website attractive through the use of colors and other functionalities. JavaScript and Jquery were used to make the webpage interactive. PHP was used to connect the database to the website while MySQL was the language used to communicate with the database. Bootstrap helped to make the website responsive and Xampserver helped to implement the website offline before taken it online. Python programming language was used for creating the machine learning model for the system.

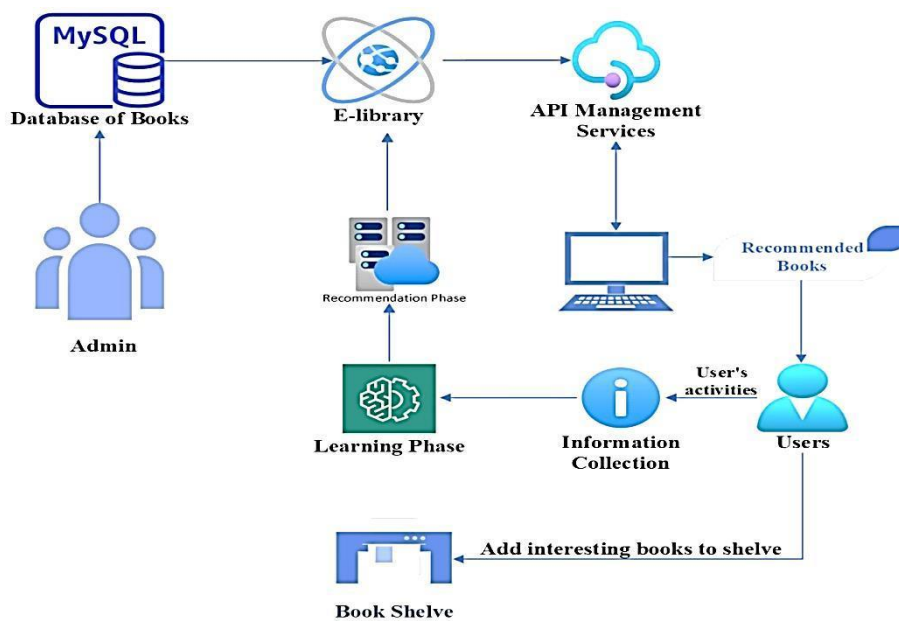


Figure 1. The proposed e-library and recommendation system

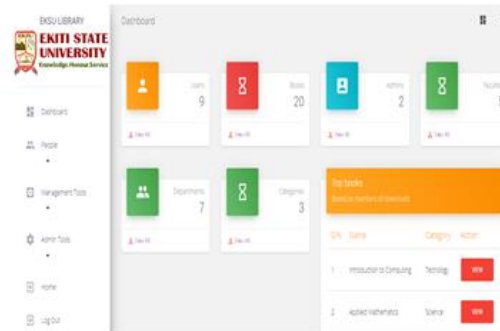
3. RESULTS AND DISCUSSION

The e-library system is web-based and was built using HTML, CSS, and JavaScript. The different interfaces for the web-based e-library system are shown in the following figures.

Figure 2a shows the admin log in page which allows him/her to gain access to the system by providing appropriate username and password. Figure 3b is the admin dashboard which provides direct access to important information at-a-glance for quicker management of the e-library system.



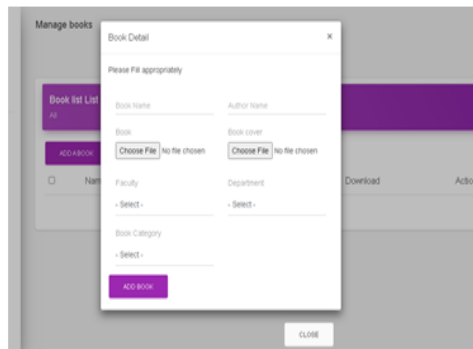
(a) Admin Log in Page



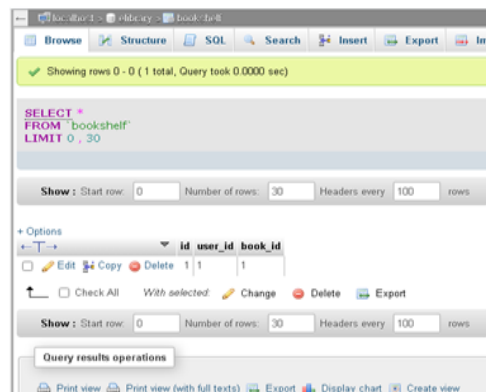
(b) Admin Dashboard

Figure 2. UI for Admin

Figure 3a shows the process of adding each book to the system by the admin, while Figure 3b shows the database of the book added to the system.



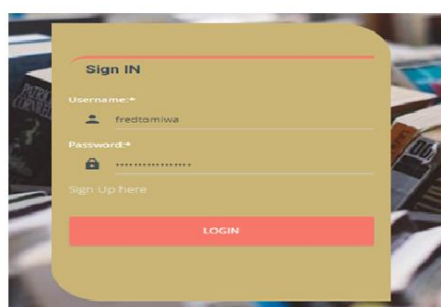
(a) Admin adds book page



(b) Database of books added to shelf

Figure 3. UI for Admin

For a user to have access to the books in the e-library system, he/she must have an account. Therefore, the user must register, which entails that he/she fills out a form presented by the system. Figures 4a and 4b show the log-in page and the registration page for the user, respectively.



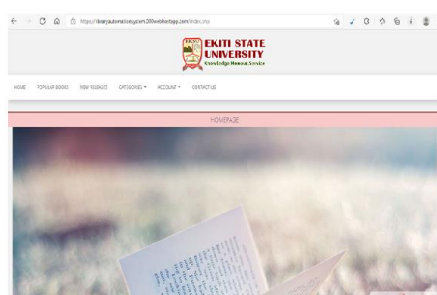
(a) User Log in Page



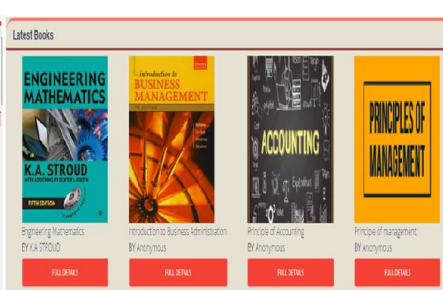
(b) User Registration Page

Figure 4. UI for User

As soon as the user logs in to the system, he/she is directed to the e-library homepage where he/she sees some of the books available on the system, which are displayed based on the date they were uploaded. Figures 5a and 5b show the E-library homepage with booklists.



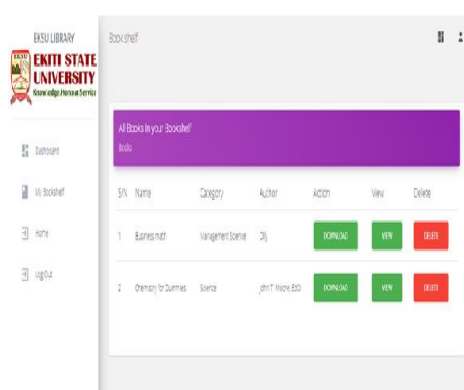
(a) User Log in Page



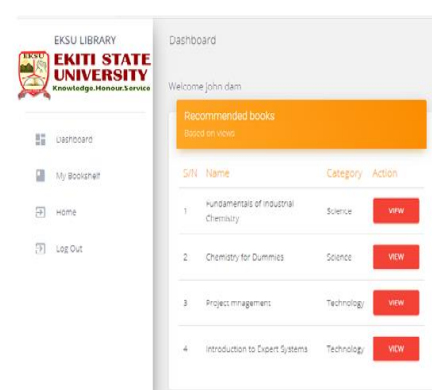
(b) User Registration Page

Figure 5. UI for User

Figure 6(a) depicts the page where books that have been added to the shelf can be viewed and read by the user, while Figure 6(b) shows the page where recommendations for books are generated for users.



(a) User's bookshelf



(b) Recommended Booklist

Figure 6. UI for User

The e-library system was set up for use by students from Ekiti State University's various faculties, which include sciences, management sciences, engineering, social sciences, and some postgraduate students. A Google form questionnaire was launched alongside the

system so that users could evaluate the system after using it based on the criteria on the questionnaire, such as system loading speed, user friendliness, interface appearance, platform compatibility, recommendation reliability, recommendation accuracy, and user experience. One hundred and fourteen (114) users used the system and completed the questionnaires for the evaluation of the proposed e-library system. A 4-point Likert scale was used to represent responses, such as "excellent," "good," "average," and "poor," respectively (Isinkaye et al, 2017). The result of the experiment is presented in Table 1.

Table 1. Results of the Evaluation of the Proposed System

Evaluation Criteria	Excellent	Good	Average	Poor
	%	%	%	%
User friendliness (UF)	77	36	0	1
User experience (UE)	86	27	1	0
Interface appearance (IA)	75	31	5	3
System loading speed(SLS)	82	29	3	0
Platform compatibility (PC)	78	31	5	0
Recommendation accuracy (RA)	80	29	4	1
Recommendation reliability (RR)	84	27	3	0

From the table, 77% of the respondents rated the user friendliness of the system as excellent, 36% rated it as good, and 1% rated it as poor. In relation to the users' experience of the system, 86% of the respondents rated it as excellent, 27% rated it as good, while 1% rated it as average. As regards the interface appearance of the system, 75% of the respondents rated it as excellent, 31% rated it as good, 5% rated it as average, and 3% rated it as poor. 82% of the respondents rated the system loading speed as excellent, 29% rated it as good, and 3% rated it as average. As for the platform compatibility of the system, 78% of the respondents rated it as excellent, 31% rated it as good, and 5% rated it as average. Also, when it came to the recommendation accuracy, 80% of the respondents rated it as excellent, 29% rated it as good, and 4% rated it as average, while 1% rated it poor. Lastly, 84% of the respondents rated the recommendation reliability as excellent, 27% rated it as good, and 3% rated it as average. Figure 6 shows the visualization chart for the performance evaluation of the proposed e-library and recommendation system.

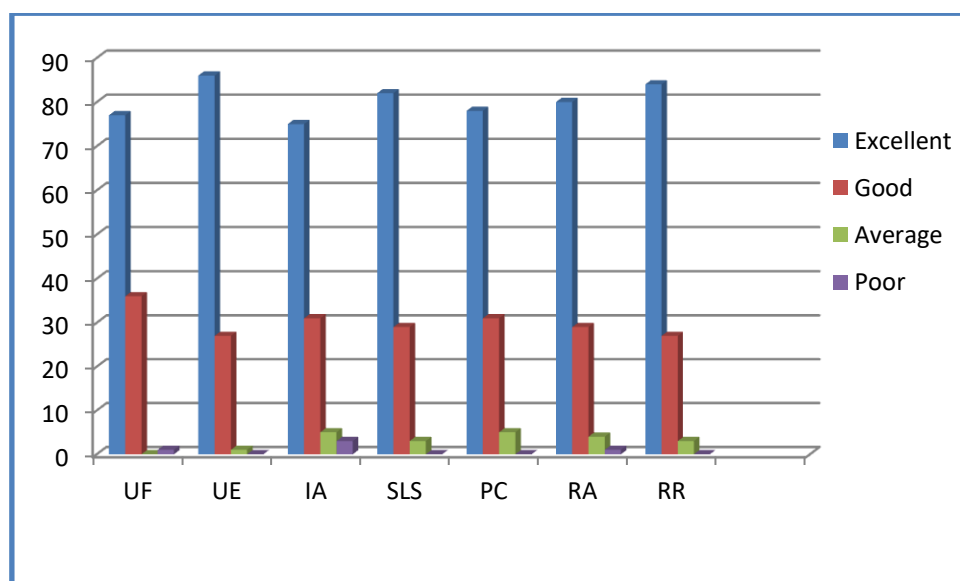


Figure 7. A Performance Visualization Chart for The Proposed System

4. CONCLUSION

Libraries are vital parts of any institution of learning, and they provide both educational and other information resources. Recently, library users are encumbered with different challenges when searching for books, either in physical or virtual libraries. Problems such as time wastage and information overload, which makes searching for personalized books among thousands of books that exist on the same subject heading (s) difficult, have led to a reduction in the number of students that are accessing libraries. In this paper, we have been able to develop an e-library system with the capabilities to help users locate books that are tailored to their needs. The system is incorporated with a recommendation component that could help users add any books they find interesting to the bookshelf for future reference and also enhance the accessibility and efficiency of the system.

REFERENCES

If references are Journal:

- [1] A. Iwayemi, and S. O. Adebayo, "Development of a robust library management system", *Int. J. Comput. Appl.*, 975, 8887, 2019.
- [2] M. R. A. Robel, S. Bharati, P. Podder, and M. R. H Mondal, "Integrated Cloud Based Library Management in Intelligent IoT driven Applications", *Fog, Edge, and Pervasive Comput. Intel. IoT Driven Appl.*, pp. 85-104, 2020.
- [3] D. Tešendić, and D. B. Krstićev, "Business intelligence in the service of libraries", *info. Technol. Libr.*, vol. 38, no.4, 98-113, 2019.
- [4] Eke, N. O. and I. A. Salihu, "Design and Implementation of a Mobile Library Management System for Improving Service Delivery", *Traektoriâ Nauki= Path of Science*, vol. 7, no.4, pp. 3001-3010, 2021.
- [5] A. Heidari, and L. Nemati-Anaraki, "Global Knowledge Networking (GKN) With Utilizing of Digital Libraries: A Proposed Model", In *Intelligent Systems: Concepts, Methodologies, Tools, and Applications*, pp. 373-395, 2018.
- [6] G. Marcel, and U. W. Faustin, "Development of an Online Integrated Library Management Information System: Case Study "University of Gitwe", *Int. J. Sci. Res. Comput. Eng.*, vol. 8, no. 2, pp. 65-76, 2020.
- [7] J. A. Alokuk, and A. Al-Amri, "Evaluation of a Digital Library: An Experimental Study", *J. Serv.Sc. Manag.*, vol. 14, no.1, pp. 96, 2021.
- [8] F. W. Singeh, A. Abdullah, and K. Kaur, "Critical success factors for digital library implementation in Africa: Solution focused rather than problem focused", *Info. Dev.*, vol. 37, no. 4, pp. 544-557, 2021.
- [9] K. Yu, R. Gong, L. Sun, and C. Jiang, "The Application of Artificial Intelligence in Smart Library", In *2019 International Conference on Organizational Innovation (ICOI 2019)* (pp. 708-713). Atlantis Press.
- [10] P. Gannamraju, S. Yarramsetti, and L. S. Kumar, "Radio frequency identification and internet of things-based smart library management system", *Int. J. Netw. Virtual Organ.*, Vol. 24, no.4, pp. 329-346, 2021.
- [11] Y. Du, Y. Lim, Y. Tan, "Activity recognition using RFID phase profiling in smart library", *IEICE Trans. Inf.& Syst.*, vol. 102, no. 4, pp. 768-776, 2019.

- [12] I. M. Oname, and J. C. Alex-Nmecha, (2020). "Artificial Intelligence in Libraries", In *Managing and Adapting Library Information Services for Future Users*, (pp. 120-144, 2020, IGI Global.
- [13] D. Daimari, M. Narzary, N. Mazumdar, and A. Nag, "A Machine Learning Based Book Availability Prediction Model for Library Management System, *Libr. Philos. Pract.*, pp.1-11, 2021.
- [14] K. S. Kumar, "Online Library Management Using Voice Recognizer Robot System", *Int. J. Res. Sci. Innov.*, vol. 3, no. 6, pp.102-104, 2016
- [15] Z. Tian, "Application of Artificial Intelligence System in Libraries through Data Mining and Content Filtering Methods. In: *Journal of Physics: Conference Series* vol. 1952, no. 4, pp. 042091, 2021). IOP Publishing.
- [16] F. O. Isinkaye and Y. O. Folajimi, "Experimental Validation of Contextual Variables for Research Resources Recommender System", *Int. J. Intell. Syst.*, vol. 10, no. 4, pp. 50-57, 2018.
- [17] F. O. Isinkaye, J. Soyemi, and O. P. Oluwafemi, "A Mobile-based Neuro-fuzzy System for Diagnosing and Treating Cardiovascular Diseases", *Int. J. Electron. Bus.*, vol.9, no. 6, pp.19-26, 2017.