Application of Information Communication Technology to the Management of Library's Readers' Desk

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ABSTRACT

The automated library's readers' desk management system is a modern innovation that is expected to help in the circulation registration of processed books and register users. The existing library management system processes in most institutions of higher learning in the developing countries is not fast enough and it is mainly manually processed. This paper presents a library readers' desk management system with the use of fingerprint biometric and barcode technology to the activities of a library's readers' services. The proposed system is capable of reducing the time spent and errors associated with identification and verification of users and library books as well as charging-in and charging-out of books to library patrons.

Keywords: Barcode, biometrics, circulation and classification/readers' desk, fingerprint, information and communications technology, ICT

1. INTRODUCTION

The capacity of information and communications technology (ICT) network has grown faster than any technology in history, doubling every two to three years. The cost of digital transmission and computer equipment has been dramatically reduced and the range of services that can be provided by ICT has been continuously expanded. The explosion of ICT since the beginning of the 20th century has been rendering manual-based library system in academic, research, special and public libraries as less relevant[1].

The library allows people to borrow and gives the borrower a time when to return the borrowed item. If the item is not returned on the due date, the person pays infringements for late or lost book charges. The circulation unit is the main public service point found at the main entrance of a conventional library. The operations performed at the readers' desk are registration of users, lending, charging in, monitoring materials for damage and routing them for repair or replacement, among others. The existing library system processes in most institutions of higher learning in developing countries are still not fast enough and are majorly manual in nature. The circulation desk unit of a library which is basically the integral part of the readers' service department needs improvement with information technology.

The advent of the internet, digitisation, and the ability to access the library and research materials from remote locations have also created dramatic changes by the end of the twentieth century[2]. The developments of expert systems, wireless networks, virtual collections, interactive web interfaces, virtual reference services, and personal web portals bring about greater changes since the start of the new millennium. The significant and fast changes in librarianship, where digital and electronic libraries are being established to complement, and in some cases to completely replace the traditional libraries and its associated services cannot be overemphasised[3].

2. RELATED WORKS

2.1 Role of ICT in Library Services

The library is divided into different housekeeping operations: Acquisition control, serials control, cataloguing and classification, circulation control, and metadata linking. Each of these has its major operations it takes care of. The circulation desk is the main public service point found at the main entrance of a conventional library. The operations performed at the circulation desk are: Registration of users, lending of materials, charging in materials returned, monitoring materials for damage and routing them for repair or replacement, etc.

Automation of the library is a key element for information industry. Research and development of library automation has grown very rapidly in recent decades and become increasingly important for the economic growth of librarianship of a developing or developed country[4].

The functions of the circulation desk which is the main public service point usually found near the main entrance of a library[5]. It provides lending services and facilities for return of loaned items. Renewal of materials and payment of fines are also handled and troubleshooting Circulation Technology, i.e., library circulation software, scanners, printers, etc. and collecting statistics on library use, i.e., patron transactions, material checkouts, etc., Circulation staff may provide basic search and reference services, though more in-depth questions are usually referred to reference librarians at the library reference desk. The circulation desk is in most cases staffed by support staff or paraprofessional instead of professional librarians. Cataloguing and classification is a system of coding and organising library materials (books, serials, audiovisual materials, computer files, maps, manuscripts) according to their subject and allocating a class mark or call number to all library resource. Library classification is said to have many standard schemes in use, and many more have been proposed over the years such as: (a) Universal schemes covering all subjects. Examples include Dewey Decimal Classification (DDC), Universal Decimal Classification (UDC) and Library of Congress Classification (LC); (b) Specific Classification (SC) schemes for particular subjects or types of materials. Examples include Icon class, British Catalogue of Music classification, and Dickinson classification, or the NLM classification for medicine and National schemes specially created for certain countries, example is Swedish Library classification system, SAB (Sveriges Allmanna Biblioteksfrening)[5].

Academic libraries, to fulfil their mission of supporting the educational objectives of their parent institutions, which include teaching, learning, research and cultural development, have to acquire and maintain core relevant books, journals, and audio-visual collections and services. Today, academic libraries are faced with multifaceted challenges in managing library collection and services as a result of inadequacy of financial support[6]. In work done by Faseum[7], the operations of a library was automated by creating a central database for the library, providing reliable security measures for the library items and data, keeping and maintaining a save record of the library, and making ways of reservation and recommendation of books and journals easy for users, while improving and reducing human stress.

The system in described by Faseum[7] also allows users to borrow books from the library remotely from a computer; this feature becomes unnecessary because the user would still have to manually collect the book from the library due to the fact that the library does not provide any carrier services. Though rare, the last copy of a book can be borrowed by two people caused by network errors. The library never lends the last copy of an item because of its users who would prefer to use the item in the library rather than borrow it. The patron is then faced with challenges when he realises what the network has caused. Another constraint faced in was the inability of the library to monitor users overdue. This challenge is an issue that every conventional library faces and tries to solve but never gets a total solution because users can borrow books and never use the library again and make it difficult for the library to track them down.

Olaniyi & Olusade[8] authors point out the opportunities provided by ICT to libraries. These are: Organization of information for use; provision of value added ICT-based information services; library cooperation and resource sharing; institutional repositories (digital local content); and content building. ICT also provides Value-added ICT-based information services such as: web-based online public access catalogues (OPACs); networked digital information resources; electronic-based interlibrary loan and document delivery services; online user education; readers' advisory and e-reference services; and providing facilities for accessing information. Academic and public libraries in Nigeria face many challenges when trying to take full advantage of the opportunities provided by ICTs. They are mainly related to: Financing and sustainability of ICT infrastructure; constant change in the ICT industry; lack of technical ICT background among library administrators; lack of adequate ICT facilities in libraries; erratic state of power generation; and low level of technical knowledge of ICTs.

Olaniyi & Olusade[8] revealed that the number of library software in the Oyo State Library Board was low couple with inadequate number of staff and most of the available staffs were inadequate in ICT skills. Major factors hindering the establishment and management of an effective use of ICT in the Oyo State Library Board were also identified. It ranged from inadequate funding, to lack of ICT hardware and software, and also irregular power supply.

Seeking access to library resources and information services in higher education libraries all over the world is undergoing tremendous transformation, especially, with the advent of ICT as tool and enabler. The application of ICT into academic libraries has improved information delivery, users can now stay in their homes and classrooms to access and interact with the libraries and receive information without physically visiting the libraries. Manir[9] reveals that ICT today is changing the work of libraries and information centres more than ever. Libraries in Africa institutions need this technology because of the

advantage it brings. Based on reality, ICT application in library activities has the ability to change the pattern of information resources access and utilisation; it will also make research and teaching simpler and easier than before.

With all the aforementioned benefits of ICT to academic libraries, the digital divide issue is still outstanding. This is the gap between those who have access to technology (telephones, computers, and internet) and related services and those who donot have access to these resources. This digital divide exists at all levels of the society, for example in developed countries vs. developing countries. ICT application has brought new changes in the library activities, but the pleasures provided do not seem to pervade the entire members of African higher institutions. For academic libraries to be effective, specific technology must be carefully matched to the need of the environment. It can be said that much of what ICT has to offer and its potential to the academic libraries has not yet been fully deployed and exploited in African Universities[8].

Outdated technologies that were first acquired in early 1980s, through 1990s are merely guarding libraries, thereby creating systemic complexities that are increasingly becoming difficult to sustain. Some universities have achieved a high degree of development with respect to ICT, in particular the acquisition of hardware and software and the setting up of local area networks (LANs) mainly as donations. Technological changes take place very often and there is a clear need to follow this trend so as not to lose out of the quality. With this process, integration of ICT is enabled in the enhancement of library activities.

2.2 Application of Biometric Technology in Library Services

Biometric represents the physiological characteristics of a person like fingerprints, hand geometry, face, voice, and iris[10]. Historically, usernames and passwords are the most common form of authenticating computer users. They are also the worst management challenge for IT staff and the biggest network security hole in existence. Many help desks handle more password related calls than any other category. Users routinely share their passwords with one another. Over the last several years, biometric devices and applications have experienced growth over the world. It leads to good security because it combines two authentication factors—'something you know' (PIN) and 'something you are'. It is easy to share 'something you know' with another user, but reasonably difficult to share "something you are". Since security mechanisms rarely have a positive impact on usability, biometrics, through templates can indeed make a system easier to use since there is no longer the need to remember passwords.

A biometric template is an individual's sample, a reference data, which is first captured from the selected biometric device. During the enrollment process, three to four samples are captured to arrive at a representative template. The individual's identity is later verified by comparing the subsequent collected data against the individual's biometric template stored in the system. The biometric templates and the overall enrollment process are the key for the overall success of the biometric application. The user will need to go through re-enrollment again if the quality of the template is poor. Templates are stored within the biometric device, remotely in a central repository or on a portable card.

The security of a library with the use of CCTVs and biometrics was proposed by Manir[7] . Foolproof security with the use of CCTV and biometrics can be achieved in libraries. Studies have revealed that there is an increase in the use of biometric technology because now that there is an improved technique of identifying authorised users, and users are ready to cooperate. Now nations are integrating biometrics technology into their organisations. The public population in major continents such as North America, Europe, and Asia prefer the use of biometrics.

Though CCTV would also be an important factor in ensuring almost total security, biometric scanners like the fingerprint scan and facial recognition gives security a greater edge[11]. Users will no longer make use of ID cards, yet access will be simple and reliable. The Fujitsu Library System and Naka City Public Library of Japan make use of the *contactless Palm Vein authentication technology* which allows lending of library materials without the use of cards.

With the Henry Identification System in use the system would work efficiently since we have palm prints of all fingers of both hands, but if it is just one fingerprint as input print, because of the distinct prints on each finger, there will not be any Primary Grouping Ratio (PGR) factor (i.e., there won't be a match anywhere in the system). The proposed system stores just one single fingerprint instead of 10 prints for an individual, thus reducing the amount of memory required to store the fingerprint templates. It also finds another method of classifying each print into their categories (which are the left and right loops, whorl and arch). Though the proposed system by Kanth & Nath[12] claims to be forty times more efficient than the existing system, there is still a problem with the system database management. Because the database should contain only one fingerprint input, the proposed system does not identify the middle and little finger, so the purpose to store just one fingerprint is meaningless. In this paper, the proposed system stores just one thumb fingerprint like the system described by Laha[13] to save time for registration and space for the database; and since it's a school library and not a security conscious company where every piece of

information and data has a very tight access. Biometric technology, over the years has been applied to different parts of the global industry for: physical access, virtual access, e-commerce applications, corporate it, aviation, banking and financial, healthcare, government, and schools. The use of biometrics is very important to institutions because many areas in an institution require identification. Picture card, pins and visual identification which are usually the common kinds of identification come with challenges of time and resources of operation. With the introduction of biometrics, money and time are saved and operations are improved. One can concentrate on safety, increase in productivity as well as practical ways of implanting biometrics in school environment where time and money[14]. Choosing the right biometric solution is also considered depending on the properties and factors of the technology.

2.3 Barcode Technology in Libraries

Barcodes are a series of vertical black lines and spaces. The barcode is a simple, compact, graphical way to record data[15]. They are machine readable. Linear (or one-dimensional or 1-D) codes, two-dimensional codes (e.g. data matrix), and composite codes (a combination of 1-D or 2-D symbologies) are available. The reported advantage of 2-D and composite codes is that they can encode more information than one-dimensional bar codes. This may be a significant consideration when examining the utility of applying barcodes to smaller medical devices, such as surgical instruments and implants.

The 1-D linear barcodes typically consist of a series of dark and light bars, either dark bars on a light background or light on a dark background, and are read by scanners, such as laser scanners. The 2-D symbologies use various combinations of dark and light shapes such as dots or dashes. Barcode information is read by an optical (laser) scanner that is part of a computer system. A handheld scanner or barcode pen is moved across the code, or the code itself is moved by hand across a scanner built into a checkout counter or other surface. The computer then store or immediately processes the data in the barcode.

The light beam flashed from the barcode scanner on the barcode label undergoes reflection at the white lines and absorption on the dark bands. This reflected light is collected back and is converted into electric pulses by the photoelectric circuitry of the scanner. Further, the pulses are converted into binary information by the interface circuitry of the scanner before they are fed to the computer, for further processing. Hence, the information read from the barcode acts as a substitute for the same information entered through a keyboard.

At the heart of each barcode system is the unique identification (ID) number assigned to every item being tracked. An ID number in the form of a barcode label is attached to every item in the inventory. When a labelled item is moved, shipped, used, disposed of, or modified in any way that should be recorded, the item's barcode is scanned and the information goes into the information tracking system. Databases help you locate and retrieve relevant information in a quick and efficient manner.

The most common barcode application for academic libraries is in the tracking of materials as they are charged out and received. In some libraries, librarians often allow students to scan books out themselves because of the efficiency of the technology. Many schools utilise battery-powered portable barcode readers as a cost-effective solution to physically take book inventory right on the shelf.

Much like a library, bar-coded student identification cards and bar-coded labelled books speed up and provide absolute accuracy to the processes of charging in and charging out books.

Barcode technology has been proven very efficient in other school applications, such as: Student attendance, which usually consumes a lot of time and energy; CTS (career technology studies) competency tracking system-data specific to the competencies of students within vocational training programmes are assembled with the use of small, portable, pocket-sized bar code readers; fixed asset tracking-with a user-friendly software and portable hardware and uniquely-encoded and durable bar code labels, desks, computers, lab or AV equipment, etc. can be tracked following the asset attributes such as date purchased, serial number and product type, and date and time it was last seen[16].

2.4 Barcoding for Faster Library Transactions

The circulation desk responsibility in an automated library involves keying in large amount of data. Sometimes, the library staffs at the counter have to retype the same information due to error in data entry. With the application of a bar coding system, which is the simplest coding technologies available, this voluminous work can be handed in a smooth manner in a much less time. The speed of data capture is three times faster than the speed at which a skilled data entry operator can input data and also the error rate is negligibly small.

Libraries can use accession number or class mark of books a unique information that distinguish library collection, as the vital information entity to barcode its collection. This information is exported from the library database/catalogue database and then converted to a series of black and white lines by the barcode software. The barcode technology is essentially a data transfer device and hence it works in perfect harmony with any of the computerised database systems.

In[16], Barcoding in library offers a lot of comfort and ease to handle bulk routine tasks efficiently[17]. The application of this technology for charging-in or out of books is widely identified and practiced in the developed countries of the world. With the help of a data gathering device, the barcodes can be used to verify stock, as libraries have to resort to stock verification, at intervals. Mishelving and wrong archiving of books are also auto-detected which helps the staff to rectify these challenges. If the parent institution also has a computerised accounting system, all the bills can be routed after bar coding so that their follow up and processing are done efficiently.

Rajindran and Bhushan[18] reveals method of library automation conducted at Raja Ramanna Centre for Advanced Technology (RRCAT) library, India by employing barcode and LibSys facilities. With these, library stock verification could be performed easily with less manpower. Laser barcode scanner for reading labels was used at the circulation counter; a portable data capturing terminal with build-in laser scanner for inventory for stock verification; and accessories such as cradle, cable, battery, and other items were the hardware installed to implement these technologies.

Barcodes are being used effectively to speed-up, avoid human error, and automate the processes in industry for production planning control, materials management, purchase sale, and inventory control. In libraries, barcode is being used to automate the data-capturing process, for stock verification, and in the circulation counter for issue/return of books, documents or books are scanned and stamped (month and year) manually at the inside back cover to avoid duplication. During scanning, the terminal stored the accession number of each document and automatically displayed the document number for a moment. If a data scanned is wrong, it can be manually updated or rescanned, and if a document has been scanned multiple times, the terminal simply stores the documents with duplicate accession numbers.

Barcode technology is reliable and easy to use. It improves accuracy and accelerates the processing time, eliminates the typing errors, decreases the costs, and improves the services. During the stock verification period, routine library activities can be carried out without any disturbance. Data-capturing terminal is handy and portable and there is no problem of scanning the data multiple times. Since there is no human intervention, the verification report generated by the system is perfect and accurate.

Academic libraries in developing countries need its readers' services activities such as charging-in and charging-out of books, registration of books, students, staff, etc. This work combines the strengths attributed with biometric and barcode technology using the library of The Bells University of Technology, Nigeria as a case study.

3. MATERIALS AND METHODS

The following scientific approaches were used to achieve the central idea of this work. They are: requirement definition and infrastructural.

3.1 Requirement Definition of the Proposed Service Infrastructure

(i)   Readers Desk System Management Requirement

This requirement follows from the assumption that to automate the library's reader's desk system, the system should provide:

(a) Eligibility and authentication: The system should be designed in a way that only allows access to authorised personnel.

(b) Uniqueness: Only one user can borrow a book at a time.

(c) Accuracy: Library staff should be able to compute records with lesser errors.

(d) Integrity: Records can only be modified, updated or deleted by the administrator.

(e) Reliability: The system should work robustly without any loss of records due to good and reliable database.

(f)   Flexibility: More modules of library operations can be integrated into the system to increase functionality.

(g) Convenience: Users should be able to enter/exit the library with minimal sign in/out time. Library staff handle borrow and return process faster with less errors.

(ii) Service Provision Requirement

The infrastructure should allow the readers desk to monitor registration of users, lending materials to library users, checking in materials returned, monitoring materials for damage and routing them for repair or replacement, etc.

3.2 Infrastructural Model and Architect

(i)   Overall System Architecture

The hardware phase integrated into proposed automated system involves two technologies, namely: (i) Biometric Fingerprint Scanner (Scans the fingerprints of users, (ii) Barcode Scanner (Front End), Barcode Verifier and Barcode Printer (used during the installation phase. The software phase is divided into two sub-phases: (i) Front End (application which interfaces the users would

interact with (ii) Back End (database where the information is stored. In designing the front-and back-end of the system, some development tools required are: (i) Microsoft Visual Studio (.Net Framework): The programming language used is C#, which is structured, imperative, object-oriented, and declarative, (ii) Microsoft SQL Server 2005: It is a fast, stable and true multi-user, multi-threaded SQL database server; SQL (structured query language).The main goals of Microsoft SQL are speed, robustness, and ease of use. It defines an xml data type that could be used either as a data type in database columns or as literals in queries.

The system architecture in Fig. 1 shows how the system operates and functions. It consists of a centralised database server that stores all the information about books, library users and their properties and processes. The barcodes of the books are stored via a barcode scanner in the server as strings, while the fingerprint templates of the library users are stored via a fingerprint scanner in the server as byte. The fingerprint scanner is used to register both the university staffs and students to allow them access the library during entry and

to borrow/return books. It will also be used during the charging-out and charging-in process, where library users have to identify themselves as the borrowers of a book. The barcode scanner registers the library books on the shelf and is used to increase the process of checking-in and out of the books. The application software allows the user of the system, i.e., the administrator and the library's readers' desk staff to perform the basic circulation operations, i.e., add users, charge-in and out books, as well as add more users to access the system (only the administrator can add more users of the system) and monitor the library users that enter and exit the library.

(ii) Application Framework Overview

Figure 2 gives the platform application framework of the proposed readers' desk management system. The figure above shows the integration of a barcode process and biometric process with a library's readers' desk process. With the automation of the readers' desk, circulation processes can be done easier and faster, with better security when the barcode scanner and fingerprint scanner are installed and programmed into the system.
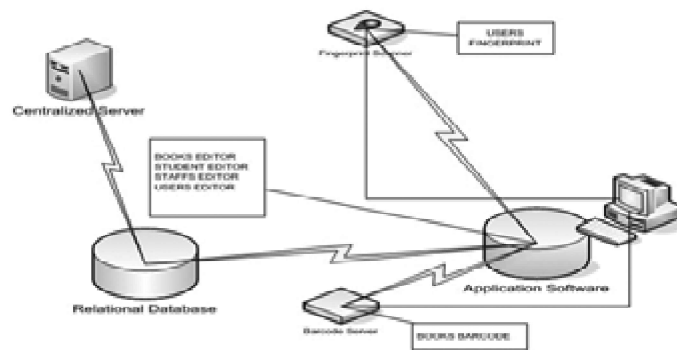
Figure 1. System architecture of proposed system.[19]
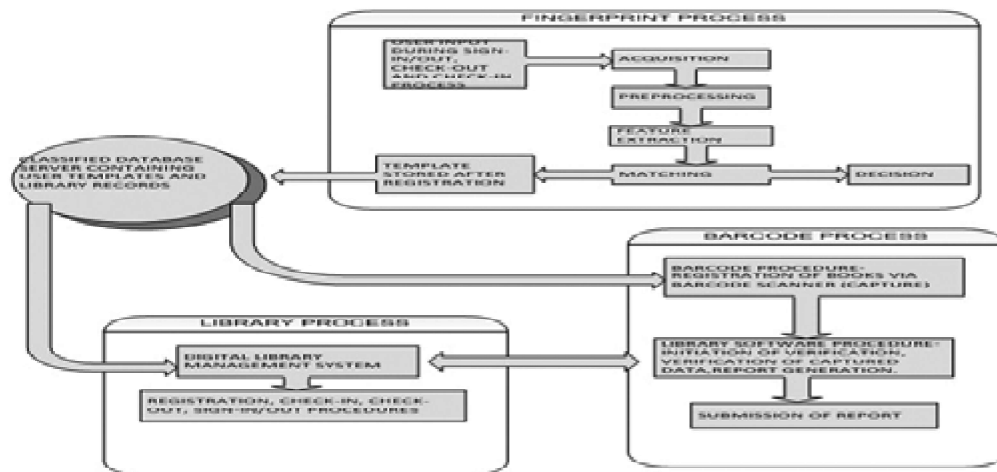
Figure 2. Framework of the Proposed System.[19]

Efficiency and effectiveness is improved after this synchronised technology.

(iii) Requirement Specification

From the architecture, two main components are required for the development and implementation of the architecture:

(a) User Terminal: The readers' desk management application resides on a terminal device which is a computer or laptop with intranet access

(b) Application Server: The application server ensures that the assumptions stated in the readers desk system management requirement above are met, authorises and authenticate library users.

(c) Analysis of Model: The structure of the proposed system can be analysed using the Use-Case diagram, Class diagrams and the behavioural/sequence diagram.

The use case scenario of the proposed system is shown in Fig. 3, showing the interactions of the library administrator, student, university staff and Circulation Desk staff on each tier of the model.

In Fig. 3, there are four main actors: librarian, students, university staff and circulation desk staff. The registered student or university staff sign-in into the library via a biometric finger print authentication and then manually search books. At the circulation desk, with the use of a bar coding system, tracking of books on shelves and a self maintained record of all books in the library are achieved.

Also, the library administrator/circulation desk staff can register books, students, charge-in, charge-out books, etc. All information here is stored in the centralised server and can be used for future reference in addition to the report accessible to the library administrator.

4. RESULTS AND DISCUSSION

The impact which biometric and barcode technologies could have on the front desk of the library is shown in Figs. 7-9. The process of charging-in and charging-out
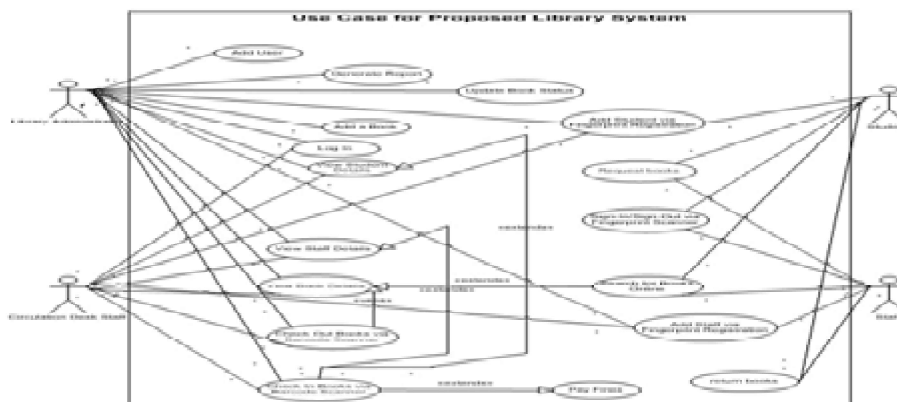
Figure 3. Use Case scenario for the proposed library readers desk system management.[19]
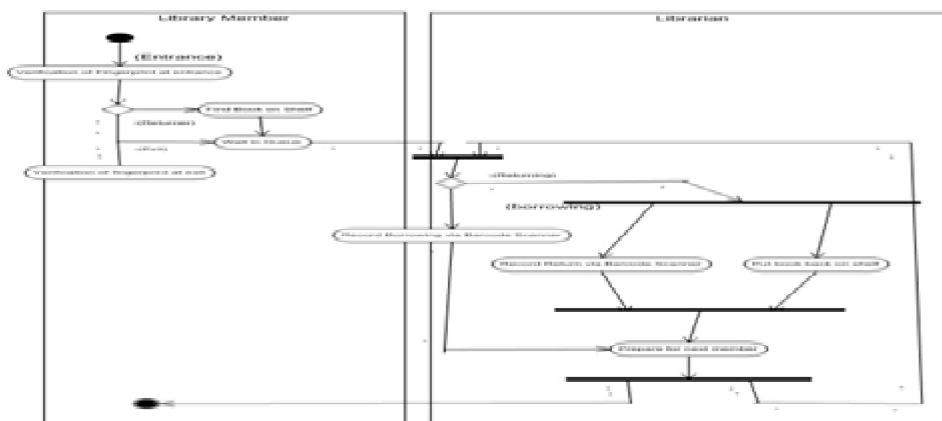
Figure 4. Proposed library readers desk system business level activity diagram.[20]

Figure 5. Automated book registration process using barcode scanner.

Figure 6. Generated report showing a list of registered library books.

Figure 7. Automated logbook during entrance into the library.
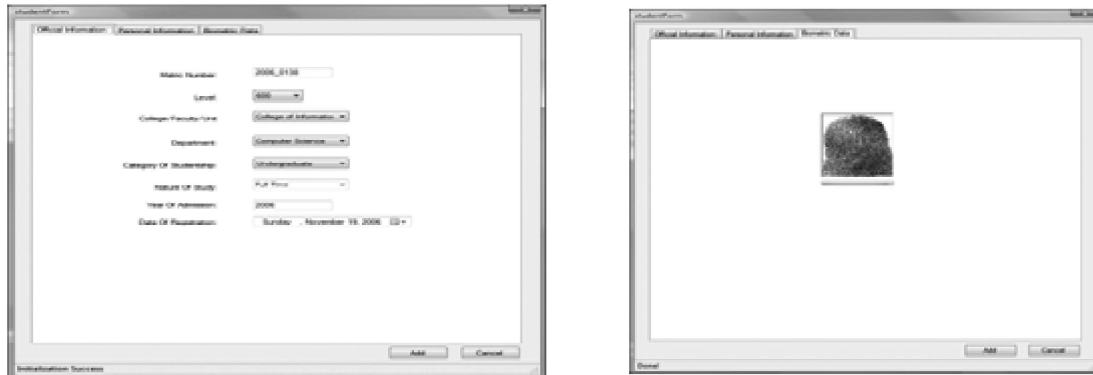
Figure 8. Process of checking-in books.

Figure 9. Registration of library users.

both the readers and tracking books available through biometric feature of readers is shown in Fig. 6 and Fig. 9.

5. CONCLUSIONS

It is essential that academic libraries keep up with developments in ICT through the application of technologies into library services. Much of what ICT and its application can offer is yet to be fully deployed and exploited in developing nations. Therefore to enable the integration of a range of ICT applications in the enhancement of the readers' activities of an academic library, biometric and barcode application is a sine quanon.These applications of this technology improve accuracy and it also takes critical factor of time and cost in the activities of the circulation unit of a library. It is easy to use and improves the operational efficiency of the readers' desk staff, thereby enabling the library to give a timely service to its users.

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