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ROADMAP FOR RFID IMPLEMENTATION IN LIBRARIES: ISSUES AND CHALLENGES

Nabi Hasan*

Abstract *The paper briefly covers the evolution of Radio Frequency IDentification (RFID) technology and elaborates the term and its importance in library management system and working. It proposes the idea of developing an RFID based system for the libraries with special reference to India. Issues related to feasibility and planning and tendering have been comprehensively covered. The deployment process and checklist for implementing the system has been discussed in detail. The paper describes the basic and optional components and procedures required for successfully implementing and working of the system. The author also discusses RFID standards and advantages and limitations of RFID use in the libraries. A comparison of Barcode vs RFID vs EM Strips vs Hybrid technology has been provided. RFID Vendors and libraries using the RFID in India have been listed. RFID scenario of Indian libraries and global RFID scenario have been explained. Besides, it outlines various issues and challenges involved in the process of implementing RFID system in libraries. The paper may help to provide an insight for libraries and librarians wishing to implement the RFID system in Indian environment.*

Keyword: *RFID, Radio Frequency IDentification, Library Authentication System, Tagging, Smart Library System*

HISTORICAL BACKGROUND

The Britishers were the first to pioneer the RFID technology during the World War II for the identification of their own aircrafts. Its further implementation started in late 1960s when the US government began using RFID to tag and monitor nuclear and other hazardous materials. In 1972, Los Alamos Scientific Laboratories transferred its technology to the public sector, which encouraged a number of companies to explore new uses of RFID. The first US patent for an active RFID tag with rewritable memory was obtained by Mario E. Cardullo on January 23, 1973. Same year, Charles Walton, a Californian industrialist, received a patent for a passive transponder that was used to unlock a door without a key. Walton licensed the technology to a lock making company called Schlage. RFID in India was developed in the 1940's for defense applications. First time it was used for commercial purpose in 1980 for cattle tracking applications. The first library RFID suppliers started to market their systems in mid 1990's. As complexities and uses increased, standards were developed to allow systems to work together. With regard to the library use of RFID, Seattle's RFID library project is the largest in the world, with Shenzhen's in second place. Today, RFID is used for automatic toll collections, access control, security, tracking objects and humans in shops, libraries, hospitals, etc. (Mittal, 2010; Nagalakshmi, 2011).

INTRODUCTION

RFID is an innovative automated library system for automatic identification and tracking of library material. It is combination of radio-frequency-based technology and microchip technology and can be used to identify, track, sort or detect library holdings. This is an effective way of managing collections of the library and providing enhanced services to the users having benefits like: to control increasing theft, to find misplaced reading material, inventory accuracy, stock verification procedures, security control, etc. It is an automatic data capture technology that uses tiny microchips and miniature antennas affixed to products. RFID plays a vital role in redefining the library processes to make everyone's job easier right from the users to library staff. It provides a platform to automate most of the processes performed by the library staff like check in-check out, sorting, stock management, etc. An RFID system consists of three important components: a tag (or multiple tags), a reader or interrogator and the necessary supporting infrastructure (both hardware and software).

FEASIBILITY AND PLANNING

Before implementation of this technology in a library, it is necessary to study the feasibility of the system. A committee may be constituted with experts and administrators who may have knowledge in RFID systems and other administrative procedures. The committee may assess the requirements for the institution, budget availability, required hardware and software, cost effectiveness, availability of manpower, time line, etc. The methodology for implementation can be divided into many phases taking into consideration of budget provisions, the types of document holdings, number of volumes, types of items meant for circulation, status of present database/automation and the number and types of users that the institution has. To implement the RFID,

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gaining management commitment may be a big challenge as it may look into the Return On Investment (ROI) to assess RFID investment before it commits to its implementation. A challenge that institutions face with is the high cost of implementation. To justify the adoption of RFID technology, cost-benefit analysis is a must. Smooth implementation of any endeavor requires thorough planning. Since the technology is still not very common, the committee should see some demos and visit the libraries where the system is successfully running. Data validation is most important before actually starting the tagging work. A feasibility report on the basis of all this exercise may be prepared and finalized.

DEPLOYMENT PROCESS & RELATED ISSUES

Tendering is the most important and difficult process for the implementation of the system in a country like India. A good tender document should look into all the minute details of the technical, administrative and functional aspects. If the tender document is fool proof then there may not be any problem in its implementation. The feasibility report prepared by the committee may help in this regard. Some of the things which should be considered for the deployment of RFID system and for preparing the tender document and to select the vender may include:

1. Proven capability of vender to integrate the proposed solution with multiple LMS for future safety (with built-in SIP2/NCIP/NISO recommended). The bidder should have sufficient successful practical experience of supply, installation, testing, commissioning and post commissioning.
2. The items to be supplied should be of proven good quality with makes having globally accepted presence and compatible with global standards.
3. Supplied equipments should allow forward compatibility with anticipated new standards.
4. Robustness of the system (scalability, accuracy).
5. Judge vendors' technology know-how for products to be supplied.
6. Ask for customer reference & arrange site visit and discuss your concerns with them.
7. Librarians should compare overall benefits vs cost involved while adopting a particular automation technology.
8. The tender may have two parts; Technical Bid and Financial Bid. The Financial bid should only be opened once the Bidder qualifies for the Technical bid.
9. Incomplete, vague and conditionally submitted bids should not be considered.
10. The validity of the successful bid should clearly be desired by the institute with a clear delivery schedule. Payment should be made after satisfactory installation and commissioning.
11. Issues related to onsite training, warranty, service and AMC should have been clearly mentioned.
12. The institute may also think to retain some security money for the post commissioning period for a couple of years.

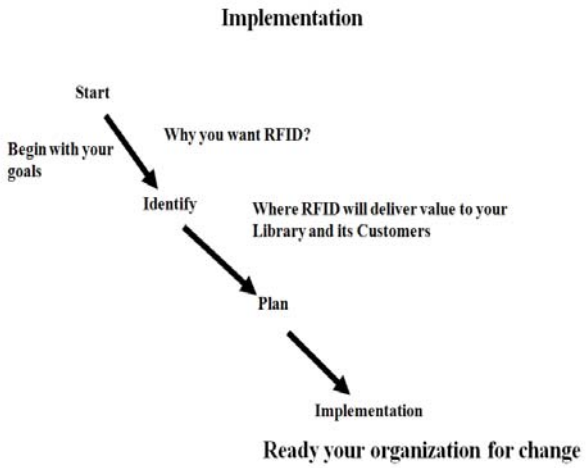

Figure 1: RFID Implementation process

COMPONENTS

RFID based library system may have the following components:

1.1. **RFID tag:** These are paper-thin smart labels which are electronically programmed with unique information, consisting of an integrated circuit and antenna coil that communicates with a reader by means of a radio frequency signal. Two types of RFID tags are available, viz. Active and Passive. Passive tags do not have their own power supply so the device is quite small. Active RFID tags have a power source and may have longer ranges and larger memories than passive tags as well as the ability to store additional information sent by the transceiver.

1.2. **RFID reader:** RFID reader consists of a transmitter, receiver, antenna and a decoder. It communicates with RFID tags, identify them and receive data stored in the tag. It provides a contact less data link which means books can be issued/ retuned without opening.

1.3. **Staff workstation** is used for the issue, return, renewal by the staff in the library and also for label personalization/tagging, etc.

1.4. **Self check-in / check-out station** allows users to borrow books without assistance from the library staff. It is an interactive station/kiosk with touch screen which prompts the user to self issue/return/renew the library documents. The validity of the membership is checked and user is prompted to place the books on to the deck of the station. The status of each book as checked-out is automatically updated in the library management database. The theft detection system of the RFID tag for that book is de-activated to enable smooth passage from the security gate. A receipt like from an ATM machine may be issued to the user confirming details of borrowed books along with the due date.

1.5. **Exit sensors** at gate antennas issue a warning signal and activate the alarm system if a document pasted with a label is leaving the premises without an authorized issue/outward entry into software. Gates are connected with warning light signals and also sound alarms to inform the security personnel that some mischief is being taken place. This gate security system composed of the desired number of pedestals, i.e. generally 2 to 4. It may also be used to count the incoming/outgoing people with a facility to record their movement. The system may be integrated with electronic counter, webcam trigger, CCTV recordings, etc.

1.6. **Shelf management system** or Potable Shelf scanner allows library staff to take inventory and find wrongly shelved books without having to pull the books off the stacks. It is very useful for stock verification purpose.

1.7. **Book drop kiosk** checks in the books when users drop them in the book drop box. Upon completing the return, the user will receive a receipt showing how many and which books were returned. The theft detection system into the smart labels is simultaneously activated. Since the books have already been checked in and RFID tags activated, they can go directly back onto the shelves.

1.8. **Application software** is used for the reader to transmit or receive data from a tag. Software integrates the reader hardware with the existing library automation software for seamless functioning of circulation section.

1.9. **Server/docking station** is one on which the software that interfaces with the integrated library software is loaded. It is the communication gateway among the various components. It receives the information from one or more of the readers and exchanges information with the circulation database. Its software includes the API (Applications Programming Interfaces), necessary to interface it with the automated library system. The server typically includes a transaction database so that reports can be produced.

1.10. **Patron cards** are Smart Cards which are used for RFID based library transactions. These cards can also be used as institute ID card, for paying fees, fines, printing or other fee-based services; for gaining Internet access; for photocopying and more. In addition, RFID is increasingly used with biometric technologies for security.

1.11. **Integrated video surveillance:** Today's Library RFID systems comes with integrated monitoring system by which you can install the video cameras on different locations of the library and monitor the movements of the users and staff with the recording facility to review at a later stage as and when required. Staff can keep an eye on the suspicious activities prior to rise of any problematic situation. This facility gives protection, flexibility, monitoring/navigation from remote location.

Figure 2: Smart Library Functions and Integrated Robotic Circulation

People counter: RFID systems also have facility to record the incoming/outgoing members of the library with their details. If a library member is passing through the EAS pedestals with Smart Card, its movement is recorded with details which help in maintaining the statistics and other details for various uses.

Integrated Robotic circulation system: Some of the libraries in developed countries like USA are

also using the Robots for circulation integrated with the RFID system. Books/documents in this system are arranged in different enclosures and not as per the classified order to enable the robot to identify the required documents for the users for the issue and then to place it back after return at its original location. Some of the Examples includes: Mansueto Library, University of Chicago; Valparaiso University, Indiana; Colgate University, Hamilton, NY; USA, etc.

1.14. **Book ATMs:** The machine is a sort of "book dispenser" similar to an ATM in many aspects, which allows library card holders to borrow and return books without needing to visit a library. There are also the Book ATMs which are used for Book selling as well.

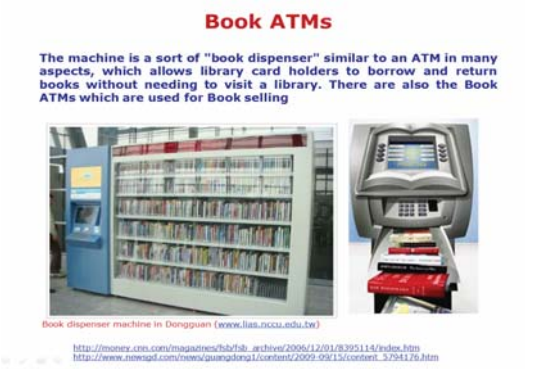

Figure 3: Book dispenser machine (www.lias.nccu.edu.tw)

RFID STANDARDS FOR LIBRARIES

There are three important ISO standards pertinent to library RFID systems: ISO/IEC 15693 Standards, ISO/IEC 18000-3 and ISO 28560. These standards works on 13.56 Mhz (HF). The tags and the equipments used may carry the FCC certifications. They may follow the NCIP V2.0 or SIP2 protocol (http://www.iso.org; http://www.iec.ch).

HOW RFID SYSTEM WORKS

The technology works through flexible, paper-thin smart labels (RFID tags), which allows it to be placed inconspicuously on the inside cover of each and every document in a library's collection. Complete information about each document is entered into the software installed in Server or Docking station. Now whenever a user brings the book for issue/return purpose, the RFID reader from the tag reads the information pertaining to that book and transmits the data into the software and book is smoothly issued in a few seconds with a minimum of manual intervention. As the user takes the book outside the library, the antenna placed at the exit gate automatically read the information contained on the RFID tag to verify whether the book is properly issued or not. In case the book is not issued to the user as per the library norms or it is being stolen from the library, the antenna senses it and give an instant alert. Thus the technology results in successful theft reduction of documents. The technology is also used for stock taking/ inventory management purpose, etc.

ADVANTAGES

Major advantages of RFID system in libraries includes:

1. The RFID tag does not have to be visible for detection. It can be read even when it is embedded in an item, such as in the cardboard cover of a book.
2. Hassle free issue/return of books since several books in a pile can be issued/ returned at a time.
3. Inventory visibility, accuracy and efficiency.
4. Increases the security function in library.
5. Instant update of the databases is possible.
6. Improved utilization of resources like manpower, infrastructure, etc.
7. Flexible library timings by use of Self Charging and Book Drop Kiosk.
8. Automation of repetitive works and improvement in library workflow
9. Enhance customer services and improve process efficiency.
10. It also enables quick shelf reading, re-shelving, sorting, searching, weeding and exception finding.
11. The system is highly reliable, claims an almost 99.9 percent detection rate using RFID tags.
12. RFID tags last longer than barcodes because nothing comes into contact with them. Most RFID vendors claim a minimum of 1,00,000 transactions before a tag need replacement.
13. The EAS exit gates have option to keep record of incoming and outgoing library users with recording.
14. The effective deployment of RFID has a potential to quickly provide accurate and reliable data. For instance, the fingerprint or picture of the cardholder can be stored onto the card.
15. The system may also be used for automated materials handling. This includes robots, conveyer and sorting systems that can move library materials and sort them by category into separate bins or onto separate carts. This significantly reduces the amount of staff time required to ready materials for re-shelving.

LIMITATIONS

1. The cost is one of the major factors influencing acceptance of RFID system in libraries. At present, the cost of RFID adoption comprise the major investment in hardware, application software, middleware, tags, cost of integrating the RFID-based system with the legacy system, etc.
2. The vendors not only charge separately for allowing integration of RFID solution with their software using NCIP V2.0 or SIP2 protocol but also sometime integration is also difficult.
3. It is possible to compromise an RFID system by wrapping the protected material in two to three layers of ordinary household aluminum foil to block the radio signal. The system may also be compromised by placing a normal coin on RFID tag or two items against one another so that one tag overlays another. That may cancel out the signals. Some interference from metallic material does occur and tag reading may not be correct. Physical damage to the tags/removal by the library users is also un-avoidable.
4. RFID reader range depends on its power and antenna size.
5. Documents like magazines, pamphlets, CDs, DVDs may not have good location for bulky RFID tags and tag cost is also significant in their case.
6. Transition phase when RFID would take over the Barcode/automated system may lead to a chaos as using both systems side by side may cause problem both for staff as well as users.
7. The moisture present in the atmosphere, especially on rainy days, affects the RFID tag. There may be some other factors as well that can influence the read/write efficiency of RFID as well like; metal, mist, distance and incorrect positioning of antennas.
8. When the distance among the tags is very close, interference between them may be made or erroneous access may occur. For example, if one patron is taking books to initiate the loan process under self-check in/out equipment (RFID reader), and another patron is standing too close to the first patron, the reader doing the self check in/out may detect the tags of books which are held by the other patron.
9. Some patrons will be opposed to any RFID related system due to the perceived privacy issues surrounding it.
10. Annual maintenance charges of post warranty period are upto 15% of the system cost which is on a very higher side.

BARCODE VS RFID

Barcode	RFID
Barcode readers require a direct line of sight, using laser technology	Reading is done automatically using RF waves
Scan and read one barcode at a time	Scan and read multiple tags simultaneously
Reading by barcode takes much more time	Reader can interrogate or read tags much faster
Human intervention is required to scan a barcode	RFID tags can be detected hands-off
It should be visible on the product for scanning	Tags can be concealed in any non-metallic items
Readability of barcode can be impaired by dirt, moisture, abrasion or packaging, etc.,	RFID tags are not that much affected by those conditions
Barcode do not have read/write memory	RFID tags have read/write memory
Less read range compared to RFID	RFID tags have a longer read range
Technology is old, outdated and less expensive	Technology is advanced, but expensive
Ability to hold limited data	More data can be stored in a RFID tag and also facility for modifying it at a later stage

EM VS RFID

Electro Magnetic (EM) technology is the most used library security worldwide, protecting billions of books and other media. The magnetic strips are difficult to detect and remove, and can not easily be shielded by the human body or other materials. If compared with the RFID technology; the EM technology only offers the security and no other facility is available with it which is offered by the RFID technology.

TECHNOLOGY

The Hybrid technology is the best solution for the libraries as it combines the Security feature of EM and all the features of RFID. However, the hybrid solution is a costly affair because every document has to be tagged with RFID label as well as with EM strip. Also the other equipments to be used for this technology are special like Exit Sensor Gates which may work with both type of systems and also required is the Magnetizing/Demagnetizing equipments, etc. For Indian environment, where there could be lot of mishandling with the RFID tags; the hybrid technology may be the best option.

VENDORS OF RFID

A list of some of the RFID vendors in India is given below:

1. 3M Library Systems, New Delhi
2. Bartronics India, Hyderabad
3. Beegees Computers, Mumbai
4. Capgemini India, Chennai
5. Ecole Solutions, Bangalore
6. Edutech, Chennai
7. Gemini Traze, Chennai
8. Grandeur Technologies, Chennai
9. GreenFuturz Software Solutions, Chennai
10. HCL Infosystems, Noida
11. IDCUBE Identification Systems, Noida
12. I-Tek, Pune
13. LibSys Corporation, Gurgaon
14. Modular Technologies India, Chennai
15. Netlink Information Systems, Gurgaon
16. R.S. Barcodes, New Delhi
17. RapidRadio Solutions, Ahmedabad
18. RFID Infotek, Mumbai
19. Total IT Solutions, New Delhi
20. VTLS Software, Noida

RFID IN INDIAN LIBRARIES

Several libraries have successfully installed the RFID solutions in India. Some of them are:

1. Anna University, Chennai
2. Bank of Baroda, Mumbai
3. BCL, Chennai
4. BCL, New Delhi
5. IGCAR, Kalpakkam
6. IIM, Indore
7. IIM, Lucknow
8. IISc, Bangalore
9. IIT Delhi
10. IIT Roorkee
11. IIT, Chennai
12. IIT, Kharagpur
13. NASSDOC, New Delhi
14. NCL, Pune
15. NIT, Rourkela
16. NIT, Surat
17. Parliament Library, New Delhi
18. Punjab University, Chandigarh
19. Sapru House, New Delhi
20. University of Pune

GLOBAL SCENARIO

The RFID in libraries was first proposed in the 1990s as a technology that would enhance workflow in the library settings. Singapore was certainly one of the first to introduce RFID in libraries and Rockefeller University in New York may have been the first academic library in the United States to utilize this technology, whereas Farmington Community Library in Michigan may have been the first public institution, both of which began using RFID in 1999. In Europe, the first public library to use RFID was the one in Hoogezand-Sappemeer, the Netherlands, in 2001. The University of Connecticut Library; University of Nevada/ Las Vegas Library, the Vienna Public Library in Austria, the Catholic University of Leuven in Belgium, and the National University of Singapore Library are among the few sites that appear to have tagged more than 500,000 items each. The most ambitious RFID program is that of the Nederlandse Bibliothek Dienst (Netherlands Library Service). It envisions implementing RFID in all of the public libraries of the country, with an item able to travel among libraries that are equipped to read the tags of all of the books, not just their own. Worldwide, RFID is used most in the United States, followed by the United Kingdom and Japan. The largest RFID implementation in academic libraries is in the University of Hong Kong Libraries which has over 1.20 million library items tagged; whereas the largest implementation for public institutions is in Seattle Public Library in the United States. Major jobbers are now including RFID tags in all library materials purchased from them (http://en.wikipedia.org/wiki/Radio-frequency_identification#Libraries). Currently, only about 8 percent of libraries world-wide are using RFID, but this figure is rapidly increasing as libraries understand the benefits and convenience of incorporating RFID into their system (Mehrjerdi, 2011).

CONCLUSION

Although, the RFID technology is quite expensive, still it has yielded excellent results for many libraries throughout the world. It is taking off in libraries at an increasingly rapid pace. It has the capability of making the management processes in the library more convenient. Moreover, RFID applications lead to significant savings in staff costs, enhance services and provide efficient results, which leads to almost fool proof security and access control. It not only provides a constant update of library collections, proper holding management, but also accomplishes real-time services. The bottom line is that the synergy between the latest technology like RFID

and libraries can create wonders resulting in empowerment of both users as well as librarians. It is recommended that smaller and new libraries should adopt RFID at an early stage since initially costs and resources involved in adopting & implementing the technology are lower compared to significant benefits it provides. Now-a-days, there are book distributors who supply new books tagged with RFID tags at no extra cost, saving recurring expenses to the institution.

The library of the not too distant future may be assumed to be very different with what we have today. It may work with a combination of computer hardware/software, RFID technology, robots, conveyor belts, computer experts, and few librarians. In the end, we can say that despite all its limitations, the RFID technology is the future of libraries but it is a supporting technology and not a competing one.

NOTE: The opinions expressed in this paper are the personal views/observations of the author and does not necessarily reflect the opinions of any of the institution/firm, etc. The paper is largely based on the original/un-published presentation entitled, "Roadmap for RFID implementation in Libraries: Issues and Challenges" made in the International Conference on Knowledge Management and Resource Sharing (ICKMARS-2012), February 28-29, 2012, organised by the Waljat College of Applied Sciences & BIT, Ranchi at Muscat, Oman. The presentation was awarded with the "Best Presentation of the Conference Award".

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