DESIDOC Journal of Library & Information Technology, Vol. 38, No. 1, January 2018, pp. 27-33, DOI : 10.14429/djlit.38.1.12351


# Implementation of RFID Technology at Defence Science Library, DESIDOC : A Case Study

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**ABSTRACT**

Radio Frequency IDentification (RFID) as a tool is being used for the better governance and management of libraries. A RFID system offers a complete package from security, theft detection, tracking, monitoring, inventory control, and act as an expedient in books circulation or charging and discharging of books; and, lessens the burden of librarians, who could be better redeployed to other productive activities in the service of the readers. RFID technology was implemented in Defence Science Library, Defence Scientific Information & Documentation Centre (DESIDOC), Delhi, in 2013. The study describes the process of implementation of RFID system in the Defence Science Library, at DESIDOC. It provides an overview of the work to implement the RFID system including the philosophy or the background or thought process that had gone into deciding in its implementation, the various features, technical specification of the library automation software and system itself. The constraints faced during the data migration and the visible advantages from the users' perspective vis-à-vis manual operation are also covered. The study concludes that implementation of RFID technology has brought a bouquet of benefits to librarians, the staff and scientists or user of the Library.

**Keywords:** RFID; Defence Science Library; Implementation; Library Security; Library Administration

## 1. INTRODUCTION

Information communication and technology (ICT) is a manifestation of all forward looking organisations. It is an enabler of significant changes in the society and fundamentally has impacted the lives of people and governance. The combination of IT and communication offers agility, flexibility, response, effectiveness and has profound impact in enhancing the capabilities where the need for federated information and data in real time cannot be over emphasised[1].

Not to be left behind in the race to catch up with the dynamically evolving technologies, libraries also have shifted gears and embraced advanced technologies to modernise and automate library functions to the extent possible. So far libraries have fared very well; adapting to all modern gadgetries and advance technologies with the vision of providing a unique experience every time a reader walked in[2].

This study chose the subject of radio frequency identification (RFID), primarily on the premise that it offers a wide range of advantages to all concerning in the community comprising of librarian and readers. It is one of the innovations built over radio frequency (RF), was first introduced in 1998 but took time to gain prominence to enable tags to identify themselves to a radio receiver. The tags are attached to a staggering range of items with a wide range of applications from cars (electronic tolls) to earrings (brand protection) to library books. It provides a pin-pointed information about the product being tracked.

Received : 15 October 2017, Revised : 07 December 2017
Accepted : 15 Deczember 2017, Online published : 01 January 2018

The history of RFID goes back to the World War II when the Britishers used it for the first time to identify their own aircrafts. It was later utilised by the US Government to supervise nuclear and other hazardous materials. Later in 1970s, the technique was thrown open for public use as Los Alamos Scientific Laboratories shared the technology for the public use. It was Mario E Cardullo from the US who acquired a patent for an active RFID tag with rewritable memory. Soon after in 1973, Charles Walton from California obtained another patent for passive transponder to unlock a door without the key[3]. In India, RFID technique was first used in 1940 for defence related application whereas for commercial purpose, it was first used in 1980 for a cattle-tracking application. The commercial usage of RFID in library-applications in India started in later half of 1990s. With increase in usage and intricacy, new standards were developed to make RFID systems functional and compatible[4].

In context of library-applications of RFID, Seattle Library Project is the world's largest library, whereas Shenzhen stands at second position. At present, RFID has multiple applications in real world like access control, security, tracking of objects and people in public places (shops, libraries etc)[3].

## 2. LITERATURE REVIEW

RFID is a technology that uses wireless radio communications for unique identification of people or assets. It allows the tracking of an item such as a library book by transmission of radio waves, an amalgamation of radio frequency and microchip[5]. "When the tagged object moves

within the range of an RFID reader the reader will pick up the wireless signal from the tag and the information can then be redirected to a computer system for processing"[6].

The RFID implementation across the libraries in Indian Institutes of Technology revealed that out of ten libraries five were using RFID. Libraries whose collection were more than 50000, have initiated to install RFID in their libraries. Cost constraint is the basic reason behind not implementing RFID technology. The lack of technology experts, integration with current systems or processes and difficulty in integrating with existing library automation systems are barriers to RFID systems[7]. Shalini[8], found that users are highly satisfied with the self-check system and do not find it difficult at the time of using it.

Roy & Kumar[9], reveals that users are extremely satisfied with the RFID applications in the library. The book drop box facility was found to be very well accepted among the user group, because of its 24 x 7 availability, the hosteller were able to return their books in the evening also.

Impact of RFID Technology on the library services and activities has increased the self check-out and check-in of books after the implementation of RFID. Another study found RFID to be more helpful in reducing book thefts. A great impact on the students was seen, motivated by the RFID system because of time saving and convenience to get the books issued and return books even after working hours[10].

Some of the major benefits of RFID technology highlighted by the respondents include, fast circulation transactions, multiple documents' self check-in, self check-out, user privacy, reliability, and reservation of books was indicated as the topmost service. Lack of information appeared to be a common problem as quoted by the users[11].

Cunningham[12] analysed the implementation of RFID at the Pilkington Library and concluded that implementation was an unequivocal success: issue and return of documents were surpassed within three months and staffing costs were reduced.

Bansode[13] studied implementation of RFID system at University of Pune Jayakar Library, has observed that library staff initially faced problem while working with RFID due to lack of training and not having technical knowledge of RFID and software. Later on library organised number of training programmes to get its staff better acquainted with the working of RFID and it has minimised the problem of issue return, stock verification and proved to be an asset for its people.

## 3. COMPONENTS OF RFID TECHNOLOGY

### 3.1 RFID Tags

RFID tags are called as transponders or labels. Tags are more or less microchips, attached to an antenna. It receives the radio signals and in response sends out a radio signal to the reader. Each tag contains a unique serial number and the product information. The storage of information on a RFID tag depends upon the vendor, application and type of tag, but typically a tag does not contain more than 2-kilo bytes of data, which is sufficient to accumulate the basic necessary information of an item[14]. RFID tags may be of two types: Active Tags and Passive Tags.

#### *3.1.1 Active Tags*

They have their own power source – an internal battery that possesses longer ranges and larger memories as compared to passive tags. These tags consist of a reader / interrogator, antenna, and a tag. Active RFID tags are of two types – transponders and beacons and work under two main frequencies of 433 MHz and 915 MHz. RFID systems working on 433 MHz are more favoured because of having an extensive wavelength allowing it to work with non-RF friendly materials such as metal and water[15].

#### *3.1.2 Passive Tags*

Passive RFID tags have no internal power source, and constitute an integrated circuit and internal antenna which is commonly referred to as an RFID inlay. They are available in all shapes and sizes and are usually intended for a particular function, material, or application.

Passive RFID tags operate at different frequencies. The principal frequencies within which passive RFID tags act have been classified as follows:

- *Low Frequency* - It lies in the range extending from 125 KHz - 134 KHz and operates from huge wavelength with generally a short read range of about 1-10 cm. This frequency can formally be used with animal tracking, as it is not merely affected much by water or metal.
- *High Frequency and Near-Field Communication* - It operates at a frequency of 13.56 MHz. It is an average wavelength usually read range of about 1 cm up to 1 m. This frequency is ideal for applications need not require a long read range. Examples are: data transmissions, access control applications, DVD kiosks, and passport security etc.
- *Ultra High Frequency* - It runs at a frequency range from 865 MHz - 960 MHz. It is usually a short, high-energy wavelength of about 1 m decoded to long read range. An average distance of about 5 m – 6 m is needed to read UHF, but up to 30 m or above is necessary to read larger UHF tags. It is generally used with race timing, IT asset tracking, file tracking, and laundry management as these applications require a distance of a meter of read range[16].

### 3.2 RFID Reader

RFID reader acts as a link between RFID tags and the server. It is a bidirectional device, which can transmit information in both the directions i.e. from the tag to the server (read mode) and from the server to the RFID tag (write mode). RFID reader consists of three basic units: a radio frequency module, a control unit and an antenna. These units communicate the electronic tags through radio frequency (RF) communication. The antenna generating the RF field is powered by the reader. The reader interprets the information stored in the chip when the tag passes through the field and sends to the server. After this, when the RFID system is interfaced with the server, it communicates with the integrated library system[5].

### 3.3 Antenna

The antenna acts as the connecting channel between RFID tags and the coupler. The radio waves activating the

RFID tags are generated by the RFID antennas when they are passing through the activation field. After a tag is activated, it can communicate with the coupler in both the directions. When multiple tags are expected in continuation, the electromagnetic field generated by an antenna exists without interruption[5].

### 3.4 Working of RFID

Self-checking systems can be used to fully automate the borrowing and returning of books. The same has been implemented at DESIDOC. Libsys, a specialised software is being used at Defence Science Library, DESIDOC to perform this. Options are displayed on the computer screen to the person using this system to borrow books. A unique code is generated to identify the person. This code acts as a personal identification number for the concerned library member. The system has a built-in RFID reader, which helps in identifying the books chosen by the library user. Following this, the check-in/out system deactivates the surveillance bit and again activates it once the book is returned. Typical working of RFID system[17] has been shown in Fig. 1.

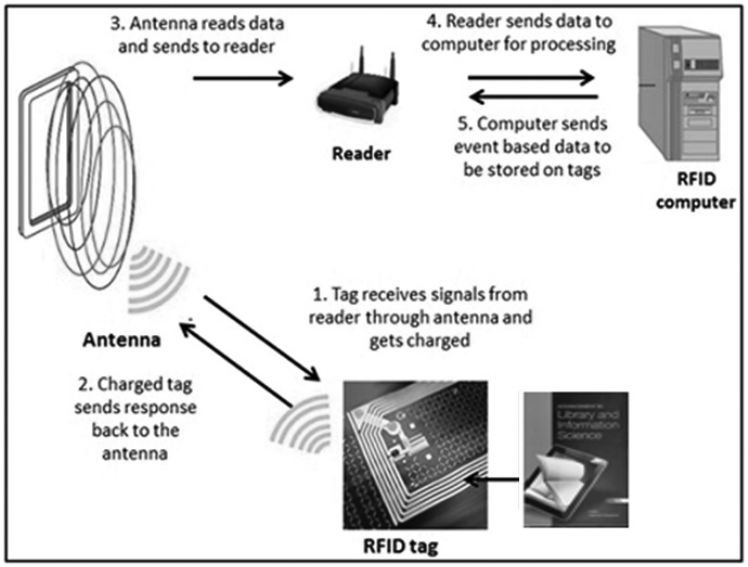



**Figure 1. Working of RFID.**

## 4. SCOPE OF THE STUDY

The study has been restricted to the Defence Science Library, DESIDOC, Delhi. The study is based on the implementation of RFID systems at DSL.

## 5. NEED OF RFID FOR DEFENCE SCIENCE LIBRARY

The Library of Defence Scientific Information & Documentation Centre (DESIDOC), Delhi is known as Defence Science Library. It has a rich collection of more than 75,000 books in various fields of S&T including rockets and missiles, defence electronics, physical and life sciences, material science, military science and technology, management, materials, and naval R&D, etc. In addition to books, it has access to 2 lakhs technical reports and 1 lakh bound volume of periodicals[18].

The library is housed in a five-storied building and the collection is arranged at each floor of the library. Stock taking of library documents was a tedious task and involves a substantial resources.

Earlier, Library was using in-house Defence Library Automation Software (DeLAS) developed and maintained by DESIDOC using VB, Java and MySQL for handling ; acquisition, serial control, circulation, and OPAC. Common communication format (CCF) was used for creating bibliographical records and for exchanging records. Since the CCF format was not widely used in recent times, it was decided to switch over to MARC records for exchange of information with other library database.

To improve stock taking and circulation process, it was decided to implement RFID system for library documents. Integration of RFID system with existing software was also a time-consuming process that involved a huge team of IT professions. To avoid this delay in implementing RFID systems along with web-based library automation software, it was proposed to implement commercial software Libsys, which has many features well suited to cater the requirements of DSL.

The implementation of RFID in the library was done in 2013 which has helped providing and accessing pin pointed, exhaustive and expeditious information services.

## 6. IMPLEMENTATION OF RFID TECHNOLOGY

In order to assess the viability of the RFID implementation, an informal group of experts was constituted. The group had discussions on distinct facets comprising budget, essential hardware and software, cost-effectiveness and the availability of manpower. The experts finally reached at a consensus and decided that RFID provides more security with efficient tracking of materials throughout the library, including easier and faster charging and discharging of documents, the potential to generate an inventory, curtailing the manual intervention and efforts in charging and discharging the documents manually. Earlier studies also recommended outsourcing of the job for carrying out the initial work of implementing RFID[13].

### 6.1 Outsourcing and Overall Requirement

As per requirement of RFID system, data migration of library records from CCF format to MARC21 format was carried out. After verifying the accuracy of each record, RFID tags were placed on each record and activated. The whole library data migration and RFID tagging was outsourced and completed around three months. Outsourcing of manpower was done for carrying out the work as the existing staff of the library was busy with their routine assignments.

The outsourced firm charged reasonable cost per record for removing the books from the shelves, placing the tags on books, verifying bibliographical records in the database and activation of tags. The total cost of the outsourced activity was reasonable which included library automation along with 50,000 RFID tags, hardware, shelf management system, and outsourcing of other necessary activities as listed in the Table 1.

**Table 1. Overall system requirements**

| Product description | Quantity |
|---|---|
| Web Centric LIBSYS7 software | 1 |
| RFID tags | 50,000 |
| Multipurpose RFID staff station | 2 |
| EAS gate antenna | 1 pair |
| Shelf management system | 1 |
| Library membership cards | 500 |
| Dual side smart card printer | 1 |
| Migration of data | 1 |
| Implementation and installation | Lump sum |
| Pasting and tagging of books | 50,000 |
| Training | 4 persons |

### 6.2 Technical Specification

Table 2 presents the technical specification required for the installation of library automation software (LibSys) and RFID systems.

### 6.3 Features

The software is integrated with the modules of acquisition, cataloguing, circulation, serial control, article indexing and WebOPAC. It also supports UNICODE and having windows based GUI. One can use web browser to access the system. It also supports Z39.50 for information exchange between the library databases. The users can also review/rate the titles, e-mail and send SMS notification. OAI-PMH support, RSS feeds and many more features are available in the software.

Screenshots of LSmart module of circulation in LibSys is shown in Fig. 2(a) and 2(b)[19].

## 7. ISSUES WHILE IMPLEMENTING RFID

(i) Conversion of records from CCF to MARC format was a challenging task since both formats are different from each other. The identification of fields in each format and placing the correct field and verification of records consumed initially a month period. The CCF format records were exported to Excel sheet along with delimiters and exported the records in MARC21 format in the database. After migration, a random checking had been carried out for accuracy of records. At the initial phase, the records of books were migrated followed by standards, reports, patents, current periodicals and bound volumes. Since the user records were to be migrated with 100 per cent accuracy, as such all 2000+ user records were manually verified. In addition, the second level of verification was also carried out before activation of RFID Tags after placing it in a book.

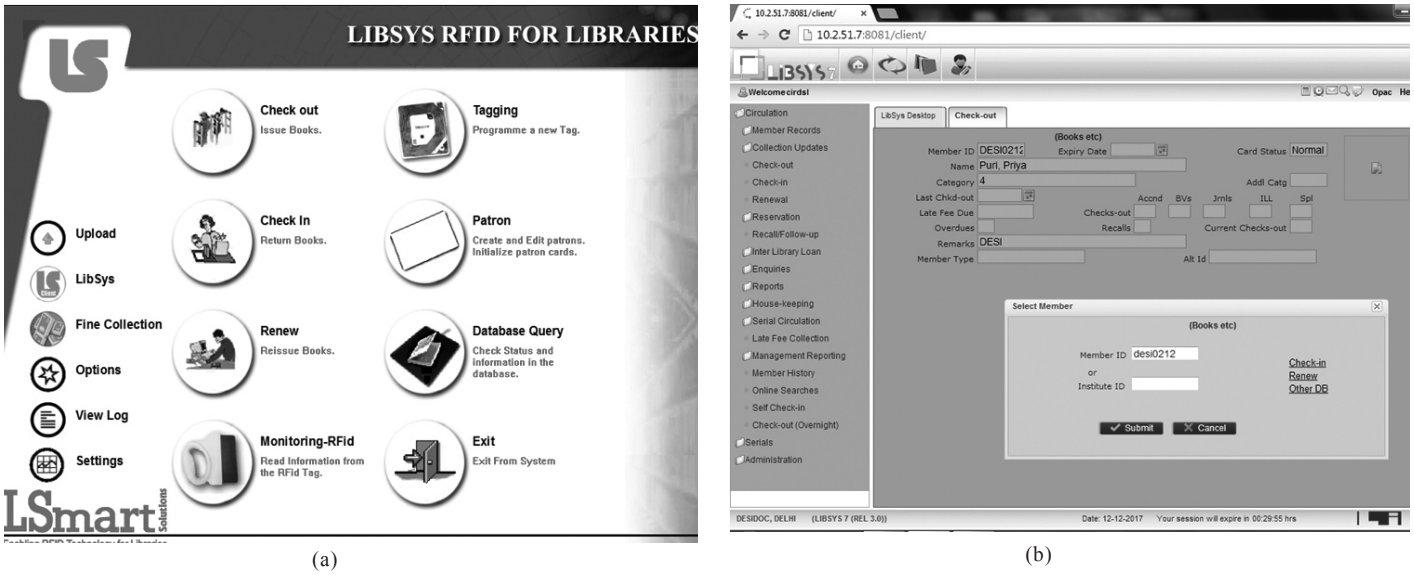
(ii) Due to lack of manpower, shelving was not carried out properly after activation of RFID tags. This lead again the library staff to do the shelving of books afresh.

(iii) Positioning of electronic article surveillance at the main entrance was again a challenging task, since the library floors made with ceramic tiles. While drilling the floor, the ceramic tiles were broken which led to the delay in mounting the surveillance system. To avoid such breaking of ceramic tiles again, a punching machine for tiles was brought in and finally the surveillance system was installed.

(iv) Stocktaking was one of the prime considerations for implementing RFID systems; however, while doing stock verification, data was not accessible at the two edges of each bookshelf. Given the fact, the books were manually removed from the shelves for reading the tags. This leads to manual interaction with automation system and proves that RFID tags cannot be read through metal or wooden surface.

## 8. BENEFIT OF RFID AFTER IMPLEMENTATION

After the implementation of RFID system, the users avail the fast issuing, reissuing and returning of the documents




(a) (b)

**Figure 2. (a) LSmart module of LibSys software and (b) Snapshot of Libsys RFID.**

**Table 2. Technical specification**

| Requirements | Technical specification |
|---|---|
| Software requirements | - License of LIBSYS7 software on one Server under Linux/Windows platform.<br>- Access of LIBSYS7 software by 5 concurrent housekeeping Users.<br>- Browser based access of OPAC by 50 Concurrent users.<br>- Data conversion from existing data in Excel to LIBSYS7 software.<br>- 4 days onsite briefing on LIBSYS7 LMS.<br>- Supply of installation guide along with manual on CD media.<br>- Data Migration from CCF to MARC21 |
| RFID membership smart cards | - HF 13.56 MHz<br>- ISO 15693<br>- User details along with photo, organisation logo printed on the cards. |
| RFID tags for books | - HF 13.56 MHz<br>- ISO 15693<br>- Operation mode: Passive<br>- Suitable for book tagging<br>- Availability of security bit for EAS Application.<br>- Adhesive for tags withstand temp. -25 °C to 70°C.<br>- Memory: 1024 bits |
| Multipurpose RFID Staff Station (Tagging, issue, return and renewal) | - HF 13.56 MHz<br>- Operating read range between 20-30 cm.<br>- RFID reader/writer integrated with antenna.<br>- Supports ISO 15693 transponders.<br>- Full anti-collision support.<br>- Operating temperature 0 °C to 40 °C<br>- Weight 1 kg |
| Shelf management system | - Operating frequency HF 13.56 MHz<br>- Support ISO 15693<br>- Anti-collision support<br>- Dimensions<br>Antenna: 60 cm long<br>Reader: 19 cm x 11 cm x 6 cm<br>- Wi-Fi Library Inventory Antenna + Reader (to enable Stock Checking; Sorting; Locating) including LSmart Client software along with mini laptop/tablet PC<br>- Operating Temperature: 0 °C to + 55 °C |
| EAS equipment | - Fit for books surveillance application<br>- Operating frequency HF 13.56 MHz<br>- RFID reader/writer integrated with antenna<br>- Supports ISO 15693 Transponders<br>- Full anti-collision support<br>- Built-in buzzer alarm<br>- Operating temperature -10 °C to 50 °C<br>- Inner cabling connection between EAS and Check-in & Check-out station<br>- Dimension: 1846 mm x 546 mm x 45 mm |
| Card printer | Dual Side Smart Card Printer with Cleaning Kit |
| Middleware | - Provision of middleware application having all necessary device drivers and error handling application. |
| Integration with the library management system | - Continuous updating of check-in/check-out information from the check-in/check-out desk.<br>- Batch mode download from stock counter.<br>- Interfacing with EAS gate reader. |
| Training | - Initial training to DESIDOC personnel for proper operation of the software. |

through self-help desks. Tasks such as exploring the number of books concurrently, searching a specific book to examine its existence in the library, locating the physical position of a book, accounting/stock verification of the materials, anti-theft detection system and authentication is carried out by using RFID technology. Simultaneously, the tedious job of stock taking of library documents has become easier for the library staff.

It has made the routine functioning of the library easier and is being generally setup at the following locations:

(i) Desktop reader/writer at the circulation counter.
(ii) Electronic article surveillance system at DSL entry gate.
(iii) Stock checking equipment used for the entire library.

## 9. CONCLUSIONS

The RFID technology has become an innate part of all modern libraries, information centres and knowledge centres, and has proved that it is efficient, effective, user friendly, and expedient. It is much better and improved technology over conventional barcodes system. Although it is expansive now, but with the time and increase in usability, it is hoped that sooner than later it will be affordable even for a small budgeted library. Needless to mention that it is just about the right time for the rightfully adaption of this revolutionary technology to reap high returns in terms of efficient services and satisfaction.

The RFID technology extensively benefited the staffers and the readers of Defence Science Library both in terms of provision and availing services. The ever-increasing library collections, stock verification and tracking of books had become a cumbersome and humanly impossible to handle. The diminishing resources, lack of trained and skilled manpower was some of the factors which forced DESIDOC to look for innovative solutions and RFID was just about the solution that was needed.

RFID offers quicker and faster circulation of books, including check-in, checkout and renewal without wasting readers time. Record keeping, and shelving of the books has become easier. The requisite manpower to discharge all these housekeeping operations is minimised, and have been redeployed for better and productive assignments in the service of readers. The system has also put a check on the misplacing of books, stealing and wrongful documentation.

There is a very little doubt that RFID technology is, the solution, but comes with relatively prohibited cost. For a small size library, the return-on-investment does not make much of economic sense to them[20].

However, as the interest in RFID as a solution to optimise further the automation and tracking of documents are gathering momentum at an increasing pace with more libraries joining the trails, it is expected that cost will soon be affordable and make a good economic wisdom both for large and small libraries.

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Her contribution in the study is conception of the idea, collection of related literature, writing and compiling the entire manuscript.