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# Implementation of RFID technology in University of Pune Library

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## Abstract

**Purpose** – The purpose of this paper is to describe the implementation of a radio frequency identification (RFID) system in Pune University Library.

**Design/methodology/approach** – The paper provides a brief overview of background of the project, barriers faced and changes that have been experienced after the implementation of the technology.

**Findings** – At the initial stage the library is facing problems with regard to the lack of availability of technology experts in the library for the RFID system and also for the software. Later on the library applied some solutions and tried to minimise the problems and now it has proved to be a boon for the library.

**Originality/value** – The paper provides insight for other academic libraries wishing to implement an RFID system.

**Keywords** Radio frequencies, University libraries, India

**Paper type** Case study

## 1. Introduction

Libraries are central agencies for the dissemination of knowledge in the form of books, journals, audio-video tapes, CD-ROMs, and via digital information services to one and all. The basic aim of any library is to provide maximum opportunities to its readers for optimum utilisation of available resources. So, libraries have been seeking technological aids to improve their customer services and management of various services offered. Barcode technology is one such tool, which is being used to improve the efficiency of libraries all over the world. Libraries began using radio frequency identification (RFID) systems to replace their electro-magnetic and barcode systems in the late 1990s (Mulla and Chandrashekara, 2006). RFID is an identification technology – it does the same job as barcodes but offers potentially a lot more (Lindquist, 2003). Owing to low data capacity and the inability to program barcodes, the scope of barcode application is limited to information access of collections and patron cards (Yu, 2008). RFID may also be seen as an enabling technology with products such as smart shelving and smart dump-bins considered by many to be technically feasible (Butters, 2007).

## 2. RFID

RFID provides for "sightless" or "no line of sight" identification of items. It includes the ability to facilitate circulation, re-shelving, theft detection, and several other important

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advantages in libraries and can either replace or supplement existing library barcodes (Coyle, 2005). When the cost of labour is taken into consideration for tasks such as checkout, check-in, inventory holds, lists, mis-shelved items, etc. RFID can prove to be very effective. According to the Taiwanese company, BookTec Information Co., which has developed an RFID library management system, LibBest:

> RFID is a combination of radio-frequency-based technology and microchip technology. The information contained on microchips in the tags affixed to library materials is read using radio frequency technology regardless of item orientation or alignment (i.e. the technology does not require line-of-sight or a fixed plane to read tags as do traditional theft detection systems) and distance from the item is not a critical factor except in the case of extra-wide exit gates (BookTec Information, 2007).

An overview of the development of RFID technology is presented in Table I (taken from Bhuptani and Moradpour, 2005).

Radio frequency based devices have been used for tracking and in theft detection for over 30 years and began to be used in libraries in the late 1990s (Hodgson, 2004; Kern, 2004). The process is similar to the rather large theft detection clip-on tags used in clothing stores, supermarkets and so on. Libraries made use of this security technology, originally as thin wires hidden in the books that would trigger an alarm if a user tried to remove the books prior to checkout. The technology worked on the bypass principle in which the trigger in the book was always on, with the staff taking the books from the user and returning them once the user was on the exit side of the security gate. These security systems have evolved into the RFID technology with its fuller integration into some library systems of today.

Library RFID technology uses radio waves operating at 13.56 MHz to identify individual items automatically, such as each individual book and member card. Specific information about that book is stored on a microchip that is attached to a coiled antenna. Often these tags are made from a special silver ink printed on paper, or they can be etched (Smart, 2004).

| | |
|---|---|
| 1930-1940 | American navy research laboratories developed a system known as IFF (identify friend or foe) |
| 1940-1950 | The first application of RFID consisted of identifying allied or enemy planes during World War II through the use of the IFF system |
| 1950-1960 | IFF technology was used to develop the modern air traffic control system. First RFID applications in the military sector, in research laboratories and in major commercial enterprises |
| 1960-1970 | Sensormatic and checkpoint systems introduced new applications for RFID, such as electronic article surveillance equipment |
| 1970-1980 | Technological advancements led to the creation of the passive tag, and the first initiatives for animal tracking and factory automation took place |
| 1980-1990 | Many American and European companies started to manufacture RFID tags. First RFID application for automatic toll payment |
| 1990-2000 | Standards for RFID equipment interoperability were developed |
| 2003 | The Auto-ID Center from Massachusetts Institute of Technology became EPCglobal, an organisation whose objective is to promote the use and adoption of electronic product code (EPC) technology |
| 2005 | Wal-Mart launched an EPC pilot |

**Source:** Bhuptani and Moradpour (2005)

**Table I.**
History of RFID generally

## 3. Components of RFID technology

### *3.1 RFID tags*

The tag can be paper thin or thick and flexible which allows it to be placed inconspicuously on the inside cover of each book in a library's collection and user's library card. It consists of an etched antenna and a tiny chip, which stores vital bibliographic data including a unique ID number to identify each item. This contrasts with a barcode label, which does not store any information, but merely points to a database. RFID tags can be either active – having their own battery power source, or passive – having no power source of its own (Strickland and Hunt, 2005; Ward, 2003). Currently libraries only make use of passive tags, in part due to lower costs, size, and the inability to replace those tags over the lifetime of the battery.

Figure 1 shows the photograph (taken from Tagsys (2008) that supplies RFID tags) of a tag.

### *3.2 RFID reader*

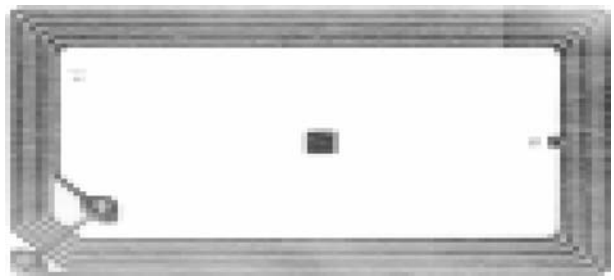
RFID readers consist of a transmitter, receiver, antennae and a decoder. They communicate with RFID tags, identify them and retrieve data stored on the tag. Readers can read documents from 30 to 45 cm. The reader is flat like a slate and it is necessary for it to be fixed to a desktop computer and configured with the library software. Since a passive RFID does not have its own power source, it draws power from the reader's magnetic field and uses it to power the microchip's circuits and antenna, which in turn enables the chip to transmit the identification information to the reader. The tag can be placed inside the book to reduce wear and tear. The read time for a tag is typically $< 100$ ms. Additionally, multiple books with corresponding tags can be read at once rather than one at a time (Scire, 2003, p. 55).

### *3.3 Antennae*

The RFID antenna connected to the RFID reader, can vary in size and structure, depending on the communication distance required for a given system performance. The antenna activates the RFID tag and transfers data by emitting wireless pulses. Antennae are of two types:

(1) long-range reader; and

(2) medium-range reader.



**Source:** Tagsys (2008)

**Figure 1.**
RFID tag

The Jayakar Library at the University of Pune is using a long-range reader which has the capacity for tracking 40 books at one time, i.e. the capacity for identifying 40 documents at a time while users pass through the gates and show their issuing status.

*3.4 RFID hand reader*

The function of an RFID hand reader is the same as that of a flat reader but it is handy and can move around the stacks. It can be connected and configured with a palmtop computer. It needs software to run the program from the palmtop with a wireless connection. The RFID hand reader used in Jayakar Library can store 164,000 accession numbers in one scan.

## 4. Jayakar Library, University of Pune

The Jayakar Library at the University of Pune was established in 1950. It is one of the leading university libraries in India catering to the needs of 3,000 users residing on campus and nearly 450 affiliated colleges. The Jayakar Library has more than 450,000 documents in its collection including books, bound volumes of periodicals, theses and dissertations, manuscripts, CDs and audio-video tapes. In 1990, in order to provide a better service and to promote the research activity of the university, the library started using the LibSys library management system package, developed by Info-Tek Consultants in New Delhi (www.libsys.co.in/). Almost 450,000 records have been added to the bibliographic database since then. Figure 2 shows the opening page of the online public access catalogue (OPAC) at Jayakar Library.

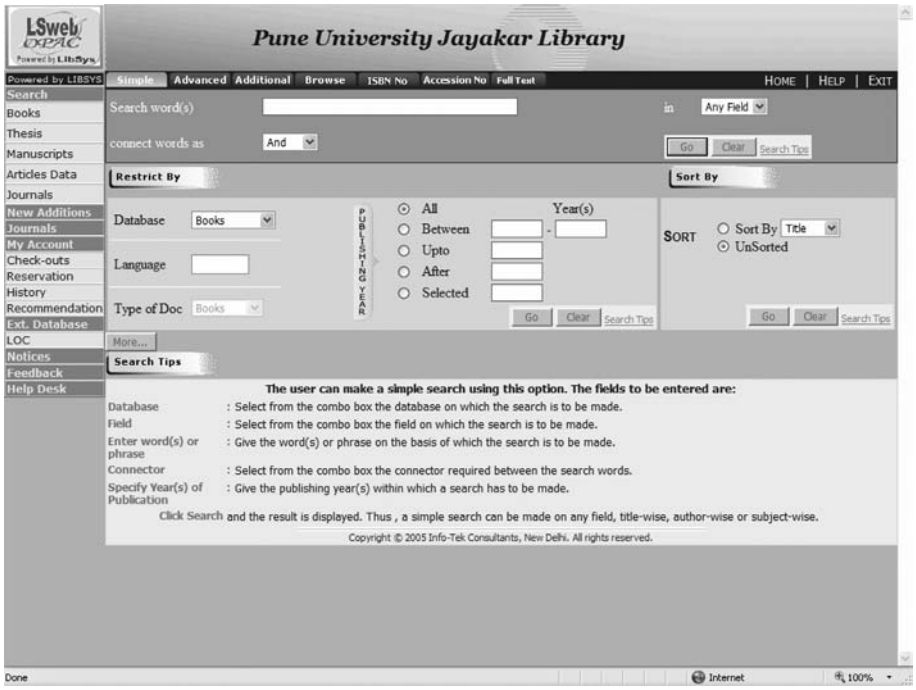



**Figure 2.**
Opening page of the OPAC at Jayakar Library

The Jayakar Library implemented barcode technology in 2000 to assist with the circulation of its stock. The barcode technology adopted in the library was not efficient enough to detect the theft of documents in the library. Library staff were investigating technology as a way to save staff time, reduce personnel costs, improve security and inventory control, but before implementation of RFID, library staff checked the feasibility of this technology for the university library.

### *4.1 Feasibility study*

The initial task of any feasibility study is to establish the aims of the project, which need to be derived from some form of users' needs assessment in the beginning. Vaishnaav and Bapat (1995) have outlined three areas of feasibility study, namely: technical feasibility; social feasibility; and economic feasibility. The central endeavour of any feasibility study is a cost-benefit analysis of the various alternatives, although a full cost-benefit analysis is unlikely to be appropriate in a library situation, particularly when the system under analysis has not yet been instituted. However, a partial analysis can yield useful insights (Rowley, 1980).

In order to assess the feasibility of the RFID implementation, an informal group of experts was formed. The group had discussions on several factors such as budget, required hardware and software, cost-effectiveness and the availability of manpower. The experts finally decided that RFID provides more security with efficient tracking of materials throughout the library, including easier and faster charge and discharge of documents, the ability to create an inventory, and enables the reduction in valuable staff time spent in charging and discharging the documents manually or by scanning with barcodes. The experts also recommended outsourcing the initial work of implementing RFID.

### *4.2 Outsourcing*

Following the experts' recommendation the initial work of RFID was outsourced. Creating a database of around 450,000 books was a huge task, which took about three years to complete. The library was not in a position to complete this task by using its existing staff who were busy carrying out routine work and so the library management decided to hire outside data-entry operators and paid them on a record-by-record basis. The temporary hired data entry operators were paid Rs. 2/- per record (approximately one US$ for 20 documents). Pasting tags in the books necessitates their removal from the stacks in order that the tags can be pasted at an appropriate place. The library appointed separate temporary staff for this project and they were paid Rs. 0.50/- per item (approximately one US$ for 80 documents). The total cost of the outsourced activity was US$ 28,125. Tagging which required careful attention was carried out by the library staff.

## 5. Barriers faced while implementing the technology

The LibSys software package includes a number of modules, e.g. LSPremia, LSmart, LSdept and LSdigital. According to its web site "LSmart is a suite of applications harnessing RFID technology for use in libraries. It is the result of integrating the power of LibSys software with RFID hardware equipment from different vendors" (www.libsys.co.in/lsmart.html). Thus, it was appropriate to use LSmart for implementing RFID in the Jayakar Library and Figure 3 shows details of this module.

While implementing RFID with the help of LSmart the library has came across following barriers.

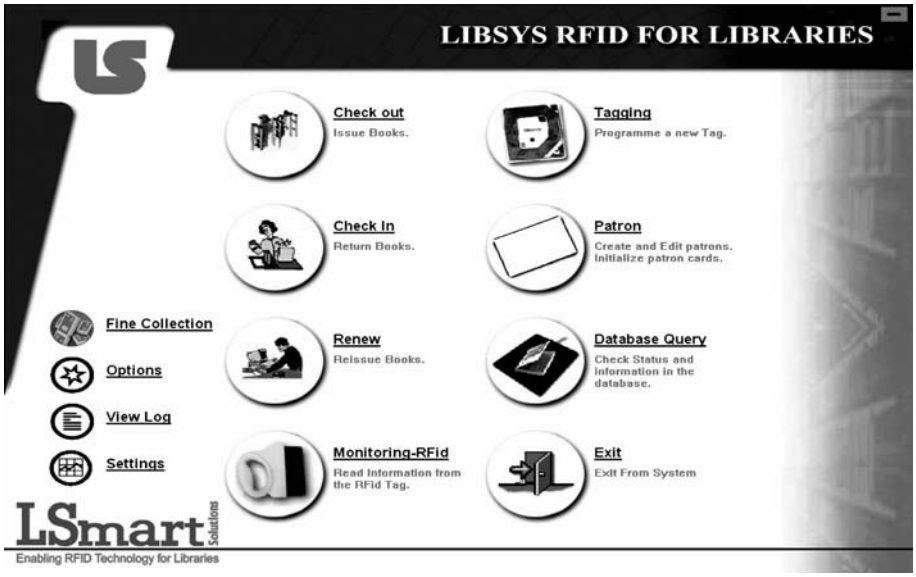



**Figure 3.**
LSmart module of LibSys software

*5.1 Lack of technology experts*

When the RFID technology was implemented in the library it was new for the library staff and none had appropriate knowledge of it. The lack of any technology expert in the library was a major barrier in the implementation. In order to overcome this barrier the library arranged various training programmes for the library staff.

*5.2 Resistance of the users towards change*

Initially, when the library started to implement the RFID technology in parallel with the manual charging and discharging system, there was resistance from the users in the adoption of the new technology. Because users were required to perform the transaction twice at the circulation counter, i.e. manually as well as using the RFID workstation, this activity was more time consuming for them. Also they were afraid that, while discharging the book if both the records were not cleared by the library staff from both the systems then they might be liable to pay fines. Also, as the users were well versed in the old charging and discharging system they were not ready to switch over to the new system.

*5.3 Technology literate users*

The technology literate users have also created many problems in the library. These users knew the function of the tags and so they removed the tags from the documents and tried to take the books from the library without charging them out in the proper way. Once the tags are removed from the documents the RFID gates were not able to detect the theft of the document and this helped some users to steal items from the library. Few such cases were recorded in the first six months in the library after the implementation of this technology.

*5.4 Lack of standards*

The emerging standard for library RFID solutions is to employ a frequency of 13.56 MHz. However, no formal standards are currently in place (BiblioTech, 2001). There has been a tendency for the library software designer, i.e. LibSys Corporation to make changes in the software so as to make it compatible according to the RFID tags used by the library.

*5.5 Moisture barrier*

The moisture present in the atmosphere, especially on rainy days, affects the RFID tag. A tag, which contains moisture, does not respond to the RFID system. The users can take advantage of this by taking items out of the library without charging. Users can pass through the antennae without charging the book by putting their palm on the tag, because the RFID signal cannot pass through a liquid medium.

*5.6 Problems with the software*

There were some compatibility problems at the start between the LibSys software and the RFID system. For instance, when the self check-out/check-in was opened for all the users it was found that in the case of overdue books the system was returning books only by using the super-user password. Also, there was no facility to personalise periodical bound volumes, books entered in the Marathi or Hindi language were not displayed on the screen and the photograph of the user was not displayed on screen. These, and other small problems, were finally solved and the LibSys software has been customised and is now running smoothly and supporting RFID.

*5.7 Problems of tagging and un-tagging*

Tagging involves the coding of bibliographic data in the RFID tag attached to a particular book or item. Once data is entered in the database it is essential to perform the tagging function. For this the LSmart tagging function is used to write, or feed, the accession number of the item on to the chip of the label. In some cases this tagging function was not performed correctly by the data-entry operators, as some wrong accession numbers were entered. This resulted in failure to retrieve the correct bibliographic details of the item at the circulation counter. Also, sometimes due to the moisture present on the tags it stops functioning. In such cases the library staff have to perform an "un-tagging" function first and then the tagging function or, in some cases, have had to replace the tag.

*5.8 Problems encountered at the circulation counter*

Staff at the circulation counter have encountered many problems while using the RFID technology. For instance, users may come to the counter with an item, which does not have an RFID tag, or the tag is removed due to heavy usage. In such cases the message such as "no book found" used to flash on the screen of the computer. Alternatively, when the bibliographic details of an item had not been entered correctly in the database the message "no accessioned book found" used to flash on the screen when a user wished to borrow the item. All such problems have been identified and remedial action for individual problems such as adding tags to the documents, or adding bibliographic details of the document in the database, were communicated to all circulation staff to overcome these problems.

*5.9 Power failure*

In India many libraries face the critical problem of electricity power supply. Jayakar Library is no exception and did not have any generator facility or any other backup system; when the power fails, staff used to shut down the circulation system. To avoid this inconvenience the library has acquired an uninterruptible power supply with a backup of 12 h. This has resulted in having proper electric power in the library and thus promotes smooth functioning of the RFID system in the library.

## 6. RFID implementation at Jayakar Library

Jayakar Library has around 3,000 registered users, with eight different member "categories" being defined in the member database. Some members can only borrow one book at a time whereas others can borrow up to 200 books. In the circulation module of LSmart, the maximum limit set for one transaction is five books and the software allows for the charging or discharging of five books in one click as shown in Figure 4.

The implementation of the RFID systems has impacted on the library in various ways.

*6.1 Saving time at the circulation counter*

Circulation includes check-out, check-in and renewal of the documents. It usually takes 1-2 min to complete a single transaction when the task is performed manually, while the same transaction takes place within 1-2 s with the RFID system. A further advantage is that if the user has five items to check-out or check-in the transaction can be easily completed within single stroke. Figure 5 shows the time taken for carrying out transactions at the circulation counter using RFID based on the transaction log for 2 min from the LibSys software.

Figure 5 shows that 23 transactions were completed within 2 min, i.e. an average of 5 s are required for one transaction. It also shows that five documents can be charged or discharged in one click. The same number of transactions takes 27 min when performed manually, while barcode-based systems take around 15-20 s for one transaction. In the case

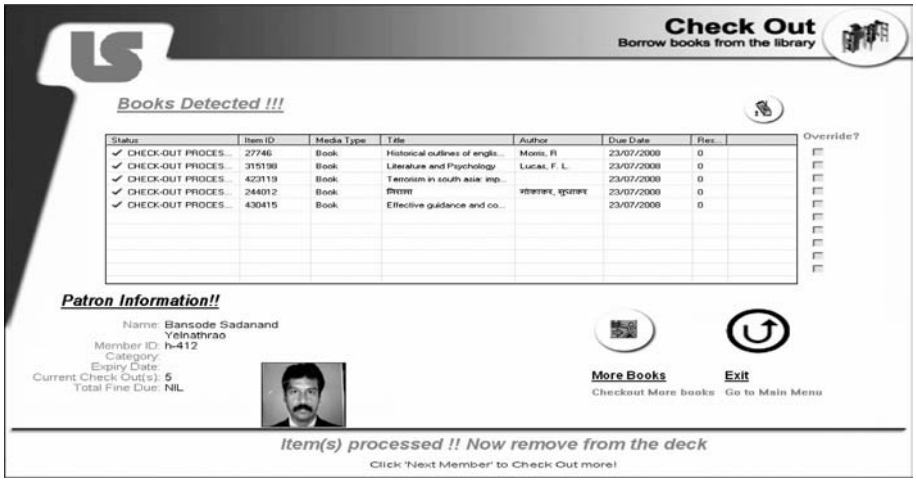



**Figure 4.**
Charging of five books in one click

Univ. of Poona, Pune TRANSACTIONS LOG Page : 1
Date : 10/06/2008

Transaction Type : All Transactions Total Txns :

| Date | Time | Txn Type | Mem ID | Tkt Accn Id | Rep Date | To Date | Init. |
|---|---|---|---|---|---|---|---|
| 10/06/2008 | 13:36 | Dchrgng | E-2968 | 374613 | 10/06/2008 | 10/07/2008 | " |
| " | 13:35 | Chrging | " | 358621 | | 10/07/2008 | " |
| " | 13:35 | " | " | 435915 | | " | " |
| " | 13:35 | " | " | 296314 | | " | " |
| " | 13:35 | " | " | 374613 | | " | " |
| " | 13:35 | Dchrgng | 297 | 296314 | 10/06/2008 | 30/06/2008 | " |
| " | 13:35 | " | " | 358621 | 10/06/2008 | 30/06/2008 | " |
| " | 13:35 | " | " | 374613 | 10/06/2008 | 30/06/2008 | " |
| " | 13:35 | Chrging | " | 296314 | | 30/06/2008 | " |
| " | 13:35 | " | " | 358621 | | " | " |
| " | 13:35 | " | " | 374613 | | " | " |
| " | 13:35 | Dchrgng | 135 | 296314 | 10/06/2008 | 30/06/2008 | " |
| " | 13:35 | " | " | 358621 | 10/06/2008 | 30/06/2008 | " |
| " | 13:35 | " | " | 374613 | 10/06/2008 | 30/06/2008 | " |
| " | 13:34 | Chrging | " | 374613 | | 30/06/2008 | " |
| " | 13:34 | " | " | 296314 | | " | " |
| " | 13:34 | " | " | 358621 | | " | " |
| " | 13:34 | Dchrgng | - H 412 | 296314 | 10/06/2008 | 10/07/2008 | " |
| " | 13:34 | " | " | 358621 | 10/06/2008 | 10/07/2008 | " |
| " | 13:34 | " | " | 374613 | 10/06/2008 | 10/07/2008 | " |
| " | 13:34 | Chrging | " | 296314 | | 10/07/2008 | " |
| " | 13:34 | " | " | 358621 | | " | " |
| " | 13:34 | " | " | 374613 | | " | " |
| " | 13:33 | Mod Bwr | 297 | | | | |

**Figure 5.**
Transaction log of the circulation counter

of barcode systems the circulation staff have to scan the barcode of the user's card and then the barcode of every item to complete a single transaction, whereas using RFID five transactions are possible in one click. This has resulted in saving the time of the users at the circulation counter and also the time of the staff. After comparing the circulation using RFID with that of a manual and barcode system one can conclude that now the circulation system has become much faster than any previous system by implementing RFID.

### *6.2 Theft detection*

The two security gates, i.e. theft detection pedestals, have been installed at the entrance and exit gates of the library. These gates are independent of each other and also have overlapping protection zones providing additional security. Any item that has not been checked-out is detected as it passes through the pedestals as shown in Plate 1. Before the implementation of RFID in the library many items were not traceable, and, apart from books being misplaced on the shelves, one of the main reasons was theft. After the implementation of RFID, Jayakar Library has managed to catch seven users who were taking items out of the library without charging. Now, since most of the users know that the system is in place and is capable of detecting theft, none are trying to take items out of the library without charging them.

### *6.3 Tracing missing books using RFID hand reader*

Previously it was very difficult to trace misplaced books because of the size of the collection and also because of the colon classification scheme used in Jayakar Library to shelve items. To locate a book it sometimes used to take 2-3 h or even two to three

**Plate 1.**
Photograph of security gates installed at the entrance and exit of the library

days, however, using the RFID hand reader library staff are able to trace any item in a few minutes. The RFID hand reader allows accession numbers of missing books to be stored and when staff scan though the stacks with the hand reader (Plate 2) an audible "beep" indicates the location of the missing item.

*6.4 Shelving books using RFID*

Once the sequence of books is defined and stored in the software (IPAQ) installed on a palmtop computer, it becomes very easy, with the RFID hand reader, to shelve books. Discharged books can easily be separated according to the rack number and location number.

*6.5 Stock verification*

Taking stock every year is an important function in all libraries and is a major challenge for those, such as Jayakar Library, with a large collection. Performing stock

**Plate 2.**
Tracing missing books from the shelves

verification manually is practically impossible for this library. Prior to implementing the RFID system, Jayakar Library was performing sample stock verification, but now with the help of the hand reader the library can regularly do its stock verification as it takes just under a week for the 450,000 items. The PDA-based hand reader can scan thousands of books/CDs lying on shelves without even a single book being pulled out, as would be the case with a barcode reader. Data is then updated instantly on the server for stock verification with the database. At the end it shows a list of matched and unmatched items. This device also helps in sorting shelves and searching for specific items.

## 7. Disadvantages of the technology

There are some disadvantages in using the RFID technology.

### *7.1 RFID tag*

The RFID readers are fairly easy to use but the key failing is the lack of security of the tags themselves. RFID is a wireless technology and is therefore subject to third-party interception unless the signal is secured (Hodgson, 2004). Only a very restricted amount of security can be incorporated in current library RFID tags due to the limited amount of data they can hold and no library tags today employ password or read access control (Molnar and Wagner, 2004).

### *7.2 Cost*

The major disadvantage of RFID technology is its cost. The readers and sensors used to read the information are comparable in cost to the components of a typical electro-mechanical or radio-frequency theft detection system (Boss, 2004). The price of hardware (per unit) varies extensively from different suppliers, however, the infrastructure requirement also varies. While RFID tags are falling in price they are still more costly than barcodes, however they do offer long-term reliability. The total cost incurred on this project was around $US 300,000.

### *7.3 Patron privacy*

There is a perception among some that RFID is a threat to patron privacy. That perception is based on two misconceptions: that the tags contain patron information and that they can be read after someone has taken the materials to their home or office. The vast majority of the tags installed in library materials contain only the item's ID. The link between borrower and the borrowed material is maintained in the circulation module of the library management system, and is broken when the material is returned. When additional information is stored on the tag, it consists of information about the item, including holding location, call number, and rarely author/title. The RFID tags can only be read from a distance of two feet or less because the tags reflect a signal that comes from a reader or sensor. It is, therefore, not possible for someone to read tags from the street or an office building hallway (Boss, 2004).

### *7.4 Lack of standards*

ISO/IEC 15693 and ISO/IEC 18000-3 Mode 1 are working towards standards for RFID but according to the NISO RFID Working Group (2007) the two standards developed by them, though related, are not equivalent.

The tags used by library RFID vendors are not compatible even when they conform to the same standards because the current standards only seek electronic compatibility between tags and readers. The pattern of encoding information and the software that processes the information differs from vendor to vendor, a change from one vendor's system to the other would require retagging all items or modifying the software (Shahid, 2005). All existing RFID systems use proprietary technology which means that if Company A puts an RFID tag on a product, it can't be read by Company B unless they both use the same RFID system from the same vendor. Standards are emerging (*RFID Journal*, 2003), but according to the industry watchers, the absence of a global standard for RFID deployment has resulted in interoperability issues and a technology that is still too expensive to acquire (Yu, 2005).

### *7.5 Lack of RFID compatible software in India*

Software that is available in the Indian market which is RFID compatible includes LibSys, LibSuite, New GenLib and VTLS. Libraries that are using other than these software solutions need to change their software or modify the software as per RFID requirements. In either case libraries need a lot of time and money, which is not economically feasible in an Indian scenario. Apart from the above listed Indian software there are some international products which are compatible with RFID namely: 3M™ Detection System, BiblioChip RFID library system, ELiMS® and Civica.

## 8. Conclusion

Implementing RFID technology has provided major benefits for Jayakar Library. Because of the growth in its collections the functions like stock verification and tracking of missing books was becoming almost impossible for the library. Jayakar Library is a university library and it serves a large clientele, and RFID technology has enabled the library to provide a quick, accurate and timely service to the users. Quick circulation of books means no queuing in front of the circulation counter, and tracking and shelving of the books has become much easier. The manpower required to perform all these functions is now being reduced and is being utilised for providing some extra services. Most importantly the system has already put a check on the theft and misuse of documents, as users understand that the system is in place and capable of detecting theft. The RFID technology has been a boon for the library, as it requires less manpower to service more books and users.

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