

Application of RFID in Shaheed Rajguru College of Applied Sciences for Women Library, University of Delhi, India: Challenges and Future Prospects

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Abstract. The paper studied many aspects of the RFID application, its budgeting, purchase process and application. It also studied advantages and limitation of RFID Technology, Documentation and Financial Implication, Challenges faced in initial stage and remedies. A structured questionnaire was designed to collect the raw data. This study employs the method of quantitative research to gather an in-depth understanding of the nature of usage of RFID system among users of SRCASW (Shaheed Rajguru College of Applied Sciences for Women) library. This study shows many authentic conclusions on data accuracy, speedy circulation, easy book identification, extension of library service, cost effectiveness, security of library materials and other value added services. Orientation program for the RFID enabled is very much important. The NFC technology can be used along with the RFID, as the application radio frequency is same in both the technology, this also incorporated in this study.

Keywords: Radio Frequency Identification (RFID), Near Field Communication (NFC), Application Family Identifies (AFI), Mifare Card, Operating Frequency, RFID Reader, Staff Station, Self-circulation kiosk.

1. Introduction

The College of Applied Sciences for Women (SRCASW) is one the primer institute under University of Delhi in Applied Sciences. The College library has more than 17000 books, many scientific encyclopedias and periodicals covering all aspect of fundamental and applied sciences, The Library offers excellent services like current awareness, selective dissemination of information, literature search, reference, newspaper clipping service. Library is fully computerized with RFID technology and under process of using Near Field

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Communication NFC enabled book rack, the library also done classification of books by DDC CD version. The library subscribes to a large number of Electronics Resources through UGC-Infonet and University of Delhi e-resources, this includes around 43200+ e-journals, NLIST- 6000 + e-journals and 135000 + online books available in three different e-Libraries which includes more than 80 computers.

Previously the library housekeeping operation was done by barcode technology, it was good enough but not sustainable with the growing needs of the library users and staff members. For example, self-circulation, self-return, auto identification of books, easy stock verification and security of books.

Today, technological improvements have changed the ways of working in business world. RFID technology is one of the emerging technologies that are being used by organizations such as manufacturers, retailers, logistics providers, hospitals, and libraries (Lee and Lee, 2009:313). Radio-Frequency Identification (RFID) technology can be defined as a wireless sensor technology which is based on the detection of electromagnetic signal (Domdouzis et. al., 2007:350).

The idea of RFID application was coined as the library going through massive users demand for more friendly books circulation, easy accessibility of books and staff needs to do stock verification and identification of books more efficiently and quickly. This study has taken deep observation of the different pros and con of RFID application and its impact among the users and staff member of the library.

2. Objectives

This paper studied many aspects of the RFID application, its budgeting, purchase process and application, Documentation, Financial Implication, Challenges faced in initial stage and remedies, RFID tag, RFID Gate, software and vendor selection. The library has taken many innovative steps to implement the RFID in a very short period of time and with a less technical glitches. After implanting the technology the library wanted to examine the user's expectation and user's reaction for confirming the effectiveness of RFID application. The major objectives of the said study are given below:

- i. to know the awareness and satisfaction level of user about RFID technology.
- ii. to identify the benefits of RFID technology in comparative to the previous system.
- iii. to ascertain the problems faced by the students at the time of charging and discharging.
- iv. to know the different technical glitches in implementing the RFID
- v. to ascertain the interoperability of RFID and NFC tags in the present library.

3. Methodology

In the present study descriptive survey method was used to know the usage of Radio Frequency Identifier System (RFID). On the basis of the objectives, a

structured questionnaire was designed to collect the raw data. This research employs the method of quantitative research to gather an in-depth understanding of the nature of usage of RFID system among users of SRCASW library. The variables selected for study are of quantitative measures. The population of this study consists of students and faculty members of the college libraries. 100 sample were distributed, out of hundred 93 sample were collected for the study, other 7 questionnaire was not received. A separate questionnaire was also prepared for the library staff.

The study has relied profoundly on both primary and secondary data. The primary data consisted of information, facts and figures collected from the library staff. 7 questionnaires were distributed among the staff, the staff questionnaire is taken to evaluate the different infrastructure available in the library and user's questionnaires were also taken in account to understand the basic reaction on RFID library system.

Random personal interviews were held and participants made many useful suggestions, the same was incorporated in the questionnaire. This face-to-face communication also helped the study to carry out the research with confidence.

The data collected is qualitative as well as quantitative in nature. The data was analyzed manually and also with the help of software packages like MS Excel. The qualitative data has been analyzed manually whereas for analyzing quantitative data MS Excel were used. The data was processed by using various statistical techniques.

4. Standard for Library Application

RFID is not a new technology (Thornton, 2006) its use in the library application is relatively new. While library RFID systems have a great deal in common with one another, including the use of high frequency (13.56 MHz), passive, read-write tags, lack of a standard and compatibility of tags produced by different vendors is a major problem in implementation of RFID in libraries. Current standards (ISO 15693) apply to container-level tagging used in supply chain applications and do not address problems of tracking and hot listing. Next generation tags (ISO 18000) are designed for item level tagging (Shahid, 2005). The standard in question was ISO/IEC 15693, first published in the year 2000. Whereas many smart-card systems require the card to be brought within a couple of centimeters to ensure correct operation, ISO/IEC 15693 systems could operate in environments where the smart-card would be read while perhaps as much as 70 centimeters away from the reader. When a vendor professes "ISO compatibility" with reference to their system, they are indicating that the tags employed in their library solution comply with parts two and three of ISO/IEC 15693. During 2004, another multi-part standard – ISO/IEC 18000 – was published which superseded ISO/IEC 15693.

4.1 AFI (Application Family Identifies)

The AFI is used in RFID systems to select a tag belonging to one particular application, while ignoring all others. The AFI is stored within a special memory on the tag. There are particular RFID radio communication commands

that can select tags belonging to one AFI, and ignore others. In addition, some library systems make use of the AFI as part of the security system – more of this later. The proposed AFI is C2 (hexadecimal).

4.2 Data Format

The data format is a mechanism used in the RFID tag to truncate (or shorten) some of the encoding on an RFID tag. It is stored as part of a single byte within a special memory on the tag known as the DSFID (Data Structure Format Identifier). The proposed data format is 6 (decimal), represented in the DSFID as xxx00110.

4.3 Object Identifier for the UII

The UII (Unique Item Identifier) is a term used in the RFID standards world to define a code that is unique in the domain of the application. In the case of library systems, it is known as the item reference, or accession code, or bar code number. The object identifier is an ISO way of uniquely distinguishing library community UII from all others. The library community has requested that this be assigned by SC31 WG4. This is possible using the following proposed OID: 1 0 15961 8 1. This will identify the loan item uniquely within the library system.

4.4 Object Identifier

Structure for other Item-attendant Data It is expected that if the standardised system for RFID in libraries is developed, other data will be encoded on the tag that is meaningful to the individual library or for the specific loan item. The root-OID does not get encoded on any RFID tag compliant with the system. The proposed root-OID is: 1 0 15961 8.

Table - 4.5: Different Tag Classes

Class	Known as	Memory	Power Source	Applications
0	EAS/EPC	None/EPC-1bit on/off	Passive	Anti-theft/ID
1	EPC	Read only	Any	Identification
2	EPC	Read-Write	Any	Data logging
3	Sensor tags	Read-write	Semi Passive/Active	Sensors
4	Smart Dust	Read-write	Active	Ad hoc networking

Table- 4.6: Operational Frequency of RFID Tag

Frequency Ranges	LF 125 KHz	HF 13.56 MHz	UHF 868-915 MHz	Microwave 2.45 GHz & 5.8 GHz
Typical Read Range	Max Shortest 1''-12''	1''-24''	Medium 1''-10''	Longest 1''-15''

(Passive Tags)				
Tag Power Sources	Using Inductive Coupling	Using inductive or capacitive coupling	Using capacitive storage, E-field coupling	Using capacitive storage, E-field coupling
Data Rate	Slower	Moderate	Fast	Faster
Ability to read near metal or wet surface	Better	Moderate	Poor	Worse
Library Application	Not so useful	Best match for library	Not so useful	Not so useful

Table - 4.7: HF Tags Chosen by the library

	HF RFID tags
Operating Frequency	13.56 MHz
Communication	One way
Standard	ISO 14443, 15693, 18000
Scan Distance	Up to 1 m
Scan Tag Simultaneously	Yes

5. RFID Implementation

The college library has started planning of RFID application in the year 2013 and RFID library operation started from 2014 onwards, which is being used for library housekeeping operation, the system move beyond security to become tracking system that combine security with more efficient tracking of materials throughout the library, including easier and faster charge and discharge, inventorying, material handling and automated book drop kiosk being used for easier return of books. The RFID system included self-circulation desk, staff work station, security gate, book drop box, RFID reader, RFID sticker for Book, RFID enabled member card, SMS and e-mail services in each book transaction.

6. Self-Adhesive RFID Tag (inclusive of Smart Card)

Sticker type HF RFID tags. The HF tags are working on 13.56 MHz frequency. It has also have the memories starting from 256 bits to 2048 bits. Tag is compatible with ISO 18000-3.

6.1 Security Exit Gate

Two pedestals with internal RFID sensor. Gate has installed at the exit gate of the Library. Width of the pedestal gate: 1.5m. It is walk through gate antenna system which is reading the tags in all three orientations. It is combination of gate antennas and long range reader. It has keep log of all items passing through the gate. It sound buzzer on Passing of unauthorized items or as per configuration set.

6.2 Staff Station Reader

Connected with desktop computer using USB. Multiple books can be placed on it for scanning at the distance of 40-50cm. It is plug & play multiprotocol reader system specially design for library application. Both operate width industry standard tags at 10.56 to 13.56 MHz. It's support ISO 15693 & ISO 14443 Tags.

6.3 Self-Check Station

With an inbuilt RFID sensor, it has capacity to sense books and member cards brought near and can display related information like name of book, author, category of books etc. It is stand-alone multiprotocol self-Check out Kiosk Primarily for issue and return of books in library. It should operate with industry standard tags at 13.56 MHz. It's support global ISO Standard like ISO 15693 & ISO 14443 etc.

6.4 Book Drop Kiosk

With an inbuilt RFID sensor, it sense books and member cards brought near and can display related information like name of book, author, category of books etc. It can return the books and issued a printed receipt. It is standalone multiprotocol book return station primarily used for returning library books. It can operate with industry standard tags and cards at 13.56 MHz. It is also support ISO 15693-3.

6.5 Portable RFID Reader

The portable handheld reader can be moved along the items on the shelves without touching them at the distance of 70-120cm. This could be used for taking inventory as well as searching for a particular book. The inventory data is exported to LMS Software for reconciliation. It is loaded with easy application development. It has the option of integrating WLAN, Bluetooth and barcode technology. It should operate with industry standard tags at 13.56 MHz. It should support ISO 18000-3 mode 1.

6.6 SMS Alert Service

The SMS alert service also enabled along with the library server, for the circulation of books the patron gets SMS, the SMS member Id, Accession number of the books and return date of the books, it also wish " Happy Reading". The SMS alert also send to the library users one day before due date.

7. Challenges in Implementing RFID

7.1 Feasibility Study

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 circulation of documents, the ability to create an inventory, and enables the reduction in valuable staff time spent in circulation, stock verification etc. the documents manually or by scanning with barcodes. The experts also recommended outsourcing the initial work of implementing RFID.

7.1.1 Software

The major challenges was in the interface of the existing library automation software and the middleware, the exiting software was Capslib which was designed in MS- Access, the sources code of the middle wear not suitable with the existing software, therefore the library purchased another commercial software, the middleware was interfaced with the new software and the library books data was imported from the old software.

7.1.2. Tagging

The tagging of the library books along with the RFID chips was outsourced, as the exiting staff was busy with the operational aspect of the library. The tagging part was supervised and examined regularly, there are two months of period was taken for pasting RFID tags to the whole library collection.

7.1.3 Power Backup

The library power back is design in fullest of reliability, there are three tire backup systems was adopted for the server and two tire backup systems implemented for the other computers including e-library.

7.1.4 Networking

Networking is the connectivity of different autonomous system on the network. Library has taken extra initiative for implementing low expenditure and smart LAN for RFID system. For that the library reserved Class-A I.P. address from the pool of I.P. address given by the University of Delhi. The reserved I.P the library are using for RFID server is 10.136.1.63 with 255.255.0.0 subnet mask and 10.136.1.1 is our default gateway i.e. first I.P of the network.

7.1.5 Users Orientation

The most challenging job was to make aware of RFID technology to the users community, in the first phase of implantation of the technology, there many students were involved in the project. After that the target group was faculty member, later on the common orientation program was done. Interestingly within a few weeks of time users of the library was very much comfortable with the new RFID technology.

7.1.6 Reputed vendors

The most difficult part was choosing of vendors, after marathon discussion with the different vendors, the library came to know that the major reputed vendors are from outside the city. After verification form the lowest quotation, a separated discussion was made the vendors that, for the support service, vendors should provide us local support service. Remote service is acceptable for

software, as far hardware is concerned local and reliable support service is required immediately.

8. Analysis and Discussion

After implementation of RFID, there are many orientations and demonstration has conducted among the users group of the library. After six months of period a survey was made to know the users awareness, acceptability and reaction to improving the RFID system in the library. On the basis of the result of the survey of the awareness, it has observed that (Fig.1) 76% of the users are well aware with the new technology, but 24% users among the total respondent in dilemma , what for the technology has implemented and how this is being used in the library. The library has provided RFID enable library (Mifare) card which is also an I-Card of the said institute.

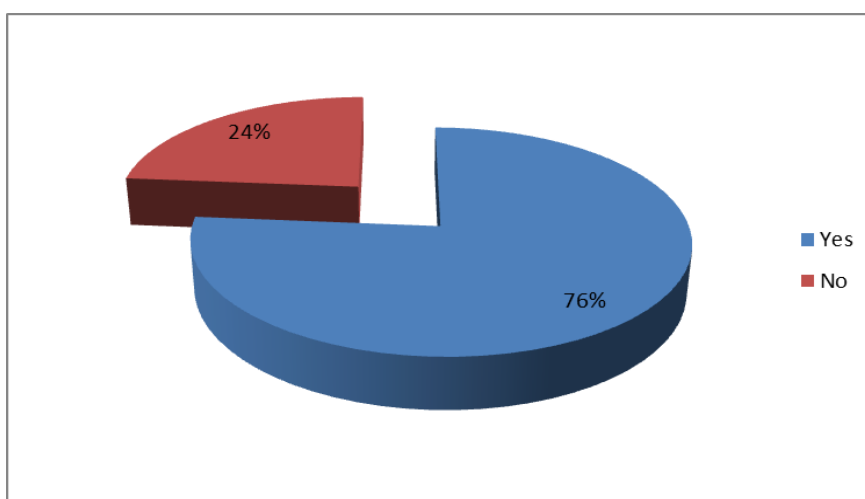


Fig-1: Awareness of RFID

The above result (Fig.-1) still worrying library staff about the acceptability of the RFID technology by the users of the library. But the positive point is that, within a six month of period the users of the library has started using the technology rapidly, even many of occasion they ask for the hand held reader to retrieve hidden books in the stack room. To overcome the less aware library users, the library initiated many more orientation program. Even a separate LED Television has mounted at the entry point of the library, which demonstrated how to use this library and RFID based self-circulation desk, book droop box and RFID reader.

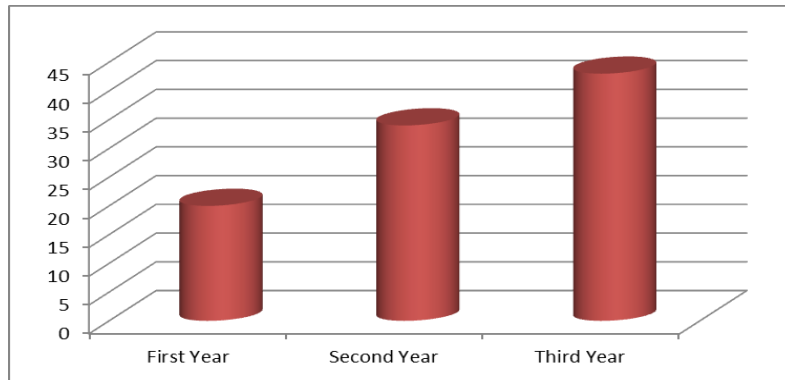


Fig-2 Awareness among the students category

The study has taken separate views from different level of students, it has shown that third years are best known of the technology, second years are more and first years students are less known about the technology. The first year students are newcomers and majority of the school library in Delhi are not RFID enabled. They are more concerned with the optical character scanner and barcode sticker. Library started special initiative to make them understand the recent technology and moreover explaining the core group, how this technology works (Fig.2).

As the result for the awareness is little disappointed, therefore the users are being asked for the requirement of Orientation program on RFID system among the users group, the 1st year students need to know more on RFID technology and its library application. The result of the survey found that majority of the first year students required more orientation, second years less and final year required lesser orientation (Fig.3).

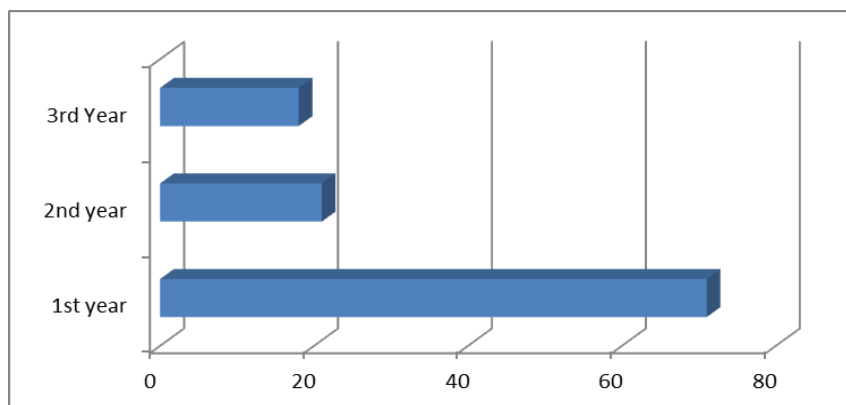


Fig- 3 Requirement of orientation program

In college library the book drop box are very popular among the users group, majority of the students are returned their books in the books drop Kiosk, as the

kiosk is running 24X7, the hosteller are returned their books in the evening also. The first morning hours the kiosk area is very busy, as majority of the student return their books at the first hour. The fine charges are collected when students coming for the next book issue. Besides book drop Kiosk, the library also facilities of self-circulation and circulation through staff station in each floor. Self-circulation also very popular among the students, and they enjoy the self-circulation kiosk issuing their own books. It's like using ATM machine (Fig-4).

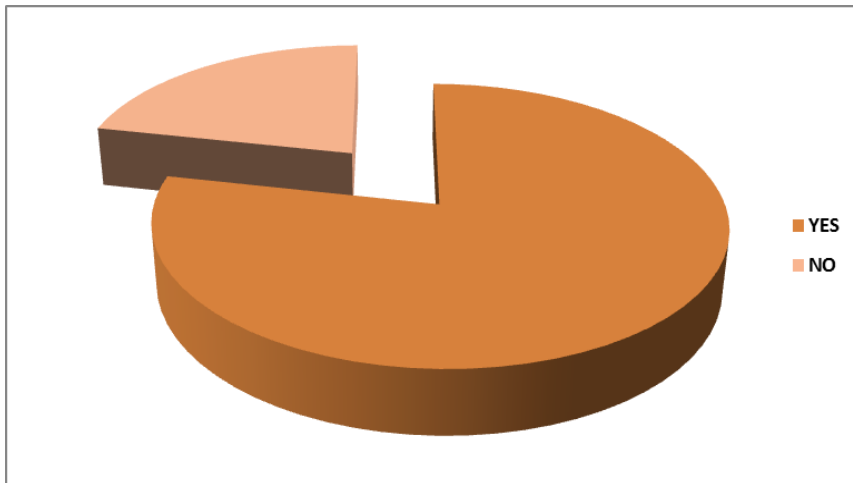


Fig-4: Circulation of Book preferred by the library users

The previous system in the library was barcode technology, where the library staff used to scan the barcode for circulation and other inventory work. RFID system boosted the speed of the house keeping operation including circulation operation. Therefore the library staff and users are happy with the system. In RFID books sticker lost its memory (appears one in three hundred circulations), it needs to retag the book detail and accordingly it take time in circulation. The stock verification has done within a week. Tracing of untraceable books also done very quickly by using the RFID hand held scanner. The majority of the library users acknowledge that the RFID increased the speed in many ways (Fig.5).

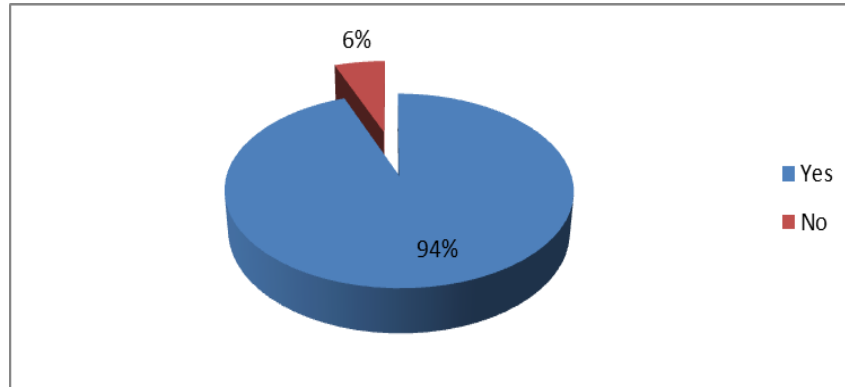


Fig- 5: Prompt vs. Slow

The RFID system is costly venture indeed, but India’s fastest growing economy permit to implement the most advanced technology in the library. Majority of Delhi University college library are in the process of implementing the RFID technology. It has experienced that the speed of the circulation, book finding and other housekeeping operation like stock verification are done very quickly. Self-circulation device make ease as staff does not involved in the process of circulation, Droop Box has extended library hours, the library timing is not constrain among the users. Besides this, the value addition service like SMS alert is extra bonus among the library users, it reduce the book late fees also. Perhaps its look like extra financial burden of the library, But at the end of the day users of the library expressed their view that the expenditure for the RFID are feasible expenditure for smarter library system (Fig. 6).

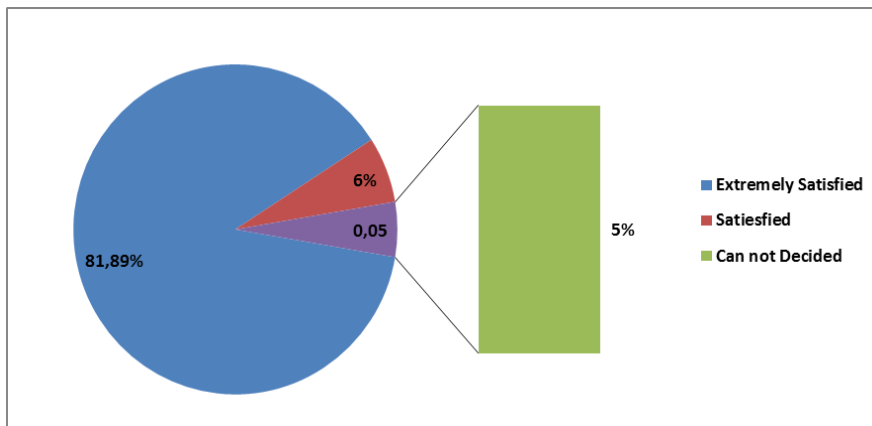


Fig-6: Cost Effectiveness

In the process of measuring the overall satisfaction of the library users and staff member are very much satisfactory. It has shown that 81.89 % are very satisfied with this technology, 6% not satisfied and 5% are undecided till date (Fig-7).

But the staff member fills proud to have such kind of smarter library in University system.

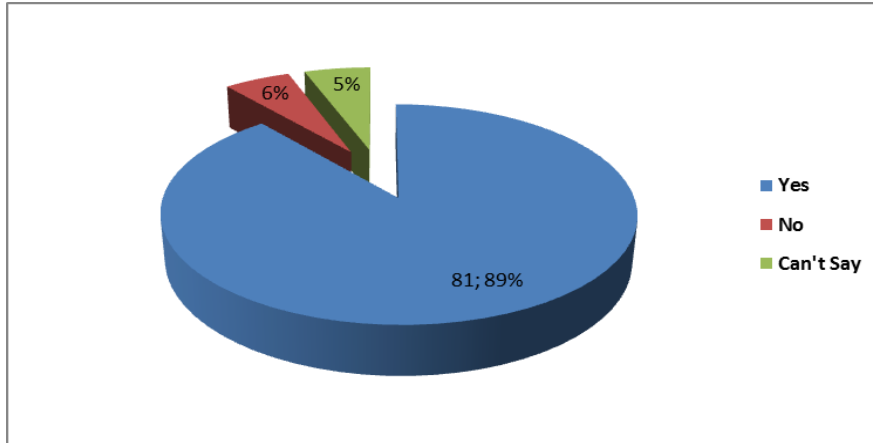


Fig-7: Overall Satisfaction of RFID System

9. Future Planning

NFC is being widely used for multiple purposes of application such as closed-loop payment, access control and ticketing. The easiest way to describe near field communication (NFC) is by telling people that NFC is contactless radio frequency identification (RFID) interface compatible with mobile phones, Tabs or NFC reader. Near-field Communication or NFC is a short-range radio technology that operates on the 13.56 MHz frequency, with data transfers of up to 424 kilobits per second, enabling communication between devices that either touch or are in close proximity, around maximum of four centimeters. It has been examined that the below listed (Table 8.1) features are almost similar in RFID and NFC.

Table - 8.1 RFID and NFC Tags

	HF RFID tags	NFC tags
Operating Frequency	13.56 MHz	13.56 MHz
Communication	One way	Two ways
Standard	ISO 14443, 15693, 18000	ISO 14443
Scan Distance	Up to 1 m	Up to 10 cm
Scan Tag Simultaneously	Yes	No

NFC's functionality is divided into three different modes: reader/writer, peer-to-peer and card emulation. Only one mode can be selected at a time, which means that, for example, when the reader/writer mode is on, the card emulation mode cannot be used. The NFC based library automation system is developed for the android hence it requires NFC enabled Smart phone having android.

System uses smart phone and NFC technology which are very reliable and can be used vice versa, as the technology is cheaper than RFID. The above experiment will framed a standard for the application of both the technology in library housekeeping operation. It also examined the economic issues of the application of RFID and NFC.

The SRCASW library already practice the seamless accessibility of RFID enable book rack with Apple iPhone 5 and Samsung Galaxy Note-II and NFC Apps. The book titles in the book rack are very much in the cell phone screen. Besides this, library in the process of installing NFC iBeacon in the each book rack, that user can access book title in their cell phone too.

10. Conclusion

Study and understanding the RFID technology and its implementation into the library is a easy task now in India. Middleware are excellent and its provides seamless accessibility with the library management software. RFID sticker and Mifare card are almost going cheaper day by day. But important aspects is, the maintenance of the huge system, one has to trained staff member ready for support and immediate support service from the external vendors.

Above all the experience of RFID application in the present library was extremely satisfactory, it's like 'dream came true'. After its success story many library professional and institutional head in India and from aboard visited the library. Library staff are now more relaxed as it's reduce many mechanical jobs. The staff members are concentrating more of value added service. Library users are extremely happy. Even the users of the library taken pride of using RFID enable library and sharing their experience with other people.

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