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RADIO FREQUENCY IDENTIFICATION (RFID) AND LIBRARIES IN THE ERA OF TECHNOLOGY

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Abstract

Radio Frequency Identification (RFID) is a new concept to be introduced in libraries of India and more particularly in the libraries of Jammu & Kashmir. The technology has helped libraries to create an atmosphere of security and proper vigilance. It has not only helped libraries to reduce the staff interference with the patrons but has also improved the efficiency of service deliverance as well. This paper aims to highlight the need for the adoption of RFID technology in libraries and other similar institutions. The paper gives an in-depth coverage of an RFID system. It starts with an introduction to RFID system and technology, and gives an outlook about role of this technology in libraries. The book gives a clear outlook about the different components and equipments of RFID technology in libraries along with their major specifications. It highlights the advantages associated with the use of RFID technology in a library-kind environment. The author of the book is currently working as Chief Librarian in J&K Higher Education Department. He has served many departments under different capacities and has the experience of installing, configuring and commissioning this RFID system in one of the prime educational institutions of the valley.

Keywords: *RFID, Library automation, Radio Frequency Identification.*

Introduction about RFID Technology

Radio Frequency Identification (RFID) is one of the most exciting modern technologies that uses electromagnetic fields to automatically recognize and track tags attached to objects. An RFID system consists of three main components: a tiny radio transponder (tag), a radio receiver and a transmitter **(Khanna & Sunaina, 2014)**. The tags are made up of an antenna and an application specific integrated circuit (ASIC) chip, which contains memory where item-specific data is stored. The tags are electronically programmed with unique information about the tagged item. The size of the tag depends on the size of the antenna, which increases with range of tag and decreases with frequency. The receiver or reader consists of an antenna, which is a Radio Frequency (RF) electronic module and is meant to communicate with the tag. The transmitter acts as a channel between RFID tags and the main data server or host computer. RFID systems can be read only (data is transferred in one direction, from the tag to the reader) or read-write (two way communication). Tags can be powered by a battery (active tags) or by rectification of the radio signal sent by the reader (passive tags).

When an electromagnetic interrogation pulse is trigged from a nearby RFID reader device, the tag transmits stored digital data or stored inventory number back to the reader **(Malipatil, 2017)**. This inventory number is the virtual representation of tagged item and hence can be used to track it. The paper highlights different auto-identification systems available in market and then gives in-depth insights about RFID technology in a library setup. It discusses different components required to install RFID technology in libraries along with their important specifications. It also enumerates important advantages of this technology over other auto-identification techniques and devices.

Different Automatic Identification Systems

Automatic identification technology also called automatic identification and data capture (AIDC) or simply Auto-ID, include a set of devices and identification procedures that are used as wireless modern technologies to ensure smoother transactions at different outlets or

point of sales (POS) **(Solanke & Deshmukh, 2018)**. In Auto-ID, different sectors makes uses of varied systems includes a very well-known barcode system, Optical Character Recognition (OCR) system, infrared identification system and Radio Frequency Identification (RFID) system, depending upon their respective needs and requirements. However, optical barcode system is clearly dominating the Auto-ID market, being used in almost everything and everywhere today in the world. Their low cost in comparison to other systems is the major contributor towards their significant usage. However, they have a limited data storage capability and 'line-of-sight' is required while operating such system. Consequently, marking the presence of an operator necessary to read a barcode or operate such a system. On contrary, tags used in RFID systems have much higher data storage capacity and also removes the human intervention in the reading process. RFID technology is coming into the Auto-ID market with a huge potential and prospective. In addition, security ensured by means of data encryption and read/write capability, unlike in barcode system, makes RFID technology a much better prospective in the future as well. Nevertheless, RFID tags require a chip to store the data, which makes this system a bit expensive to be implemented in certain Auto-ID market applications. Table 1.1 shows a comparison between optical barcodes and RFID systems.

Feature	Barcode	RFID
Data Transmission	Optical	Electromagnetic
Memory/Data Size	Up to 3 KB	Up to 128 KB
Tag Writable	No	Possible
Position of Scan/Reader	Line-of-sight	Non-line-of-sight possible
Read range	Up to several cm	Up to 100 m
Access Security	Low	High
Environmental Susceptibility	Dirt	Low
Multiple reading	Not possible	Possible
Price	Lower	Higher

Table 1.1 Comparison of barcode vs. RFID system features

RFID in Libraries

RFID technology has been used in multiple sectors as discussed in the previous sections. There are more than one million RFID systems installed in warehouses and retail establishments around the globe. However, this technology is relatively new in libraries. In 1998, Singapore Public Library claimed to be first library to use RFID technology for different operations and enjoyed remarkable success. The department published a detailed report about the use and effectiveness of this technology in library setup. Over the years, libraries have adopted the use of RFID technology and the use has grown multifariously. The introduction and use of RFID based equipments have enabled libraries around the globe to speed up the issue-return transactions and have also helped the library clienteles to check-in

and check-out in a relatively smoother manner. The control over material security, library assets and stock verification is an added advantage that this technology carries with itself. This technology has revolutionized library management as well as basic library practices. With the manufacturing of more sophisticated RFID tags, more than 90 million books have been tagged till now. In Singapore alone, more than 9 million text books and other library resources have been completely tagged, while in countries like US and Britain the process has just begin, in academic as well as public setup, to protect their library resources and assets. As far as India is concern, the concept of using RFID based equipments in Libraries is novice. However, library professional have acknowledged its importance and successfulness in improving the user oriented services and overall resource management. Consequently, projects of upgrading the library setups with RFID based technology has been initiated and started in this part of the world as well.

RFID has been used as a replacement to traditional barcodes. These RFID tags can also be used as a supplement to barcodes and offer secondary method of inventory management as well as self check-in/out by users **(Pujari & Gadgay, 2018)**. RFID tagged assets like books can be read from a distance that too in motion and without opening them. The transaction can be made without the interference of the library staff and professionals. As a result, staff requirement at the counter as well as wastage of time while accessing the library is reduced. The cost of purchasing and installing this technology in libraries has been the only hindrance in making such a dream possible. However, over the years, budget for upgrading the infrastructure of libraries has been increased globally. Which has not only helped in improving the quality of services being offered but has also attracted more and more users towards libraries. The detailed RFID components along with their importance specifications will be discussed in further sections of the study.

RFID Components

RFID (Radio Frequency Identification) is a modern wireless technology that collects and stores them using electronic tags. The stored data is the digital representation of an item, asset or book. These tags, unlike bar codes, can be even read from a distance and hence are sometimes also referred as dedicated short range communication channel (DSRCC). With multiple advantages, RFID is considered as an alternative to the bar code, that uses tiny microchips in tags to store and transfer detailed data about the tagged item. Dictionary for Library & Information Science defines RFID as "the use of microchips to tag library materials and library card, enabling patrons to check out items by walking through a self-service station equipped with an antenna that emits low frequency radio waves". Thus we can say that RFID technology uses electromagnetic or electrostatic coupling in RF (radio frequency) zone in order to identify a tagged item or object. The concept of RFID can be simplified by defining its primary role of identifying, tracking, sorting or detecting the library assets at the circulation desk. The daily stock maintenance is done by this system with the help of smart RFID labels, few hardware items and software. These sets of paraphernalia provide libraries an effective way of managing their collections while providing greater customer service to their patrons. The implementation of such type of technology in academic and public libraries not only saves the manpower, energy and time but also avoids the duplication of efforts as well. The saved resources can be utilized for the betterment and advancement of these libraries and academic institutions. The equipments and items required to configure and commission RFID technology in libraries are discussed below.

➢ Self adhesive RFID Tag
➢ RFID patron smart card

- ➢ RFID smart card reader
- ➢ Integration module software
- ➢ Server
- ➢ Staff station
- ➢ Self Check-in KIOSK
- ➢ Self Check-out KIOSK
- ➢ Security Gate System
- ➢ UHF Hand held reader
- ➢ Optional items

1. Self adhesive RFID Tag

An RFID tag is considered as the Heart of the RFID system and is a flexible, paper thin and approximately 2"x 2" in size. These characteristics enable this tag to be placed unobtrusively on the inside cover of each book in a library's collection. This tag is having three main components that include a programmable chip, an antenna and a substrate.

The chip stores vital bibliographic data including a unique ID number to identify each item. It also modulates and demodulates the radio frequency. The role of antenna is to send and receive the radio signals, while substrate is made up of a flexible material with a job to hold all the components of the tag together. The design and shape of the RFID tags enable them to be affixed into library assets like books, CDs and DVDs etc. Each tag uses volatile memory to store the information and includes either fixed or programmable logic for processing the transmission as well as sensor data. Functionally, each RFID tag has three sections:

(a) Identifier; which is a lockable section for item identification.
(b) Rewritable; that is meant for a specific use.
(c) Security; for item protection and anti theft.

RFID tags are classified under two broader categories; passive RFID tags and active RFID tags. An active tag is a battery assisted tag that communicates recurring signals in a structured manner. The battery of the tag gets activated in presence of an RFID reader. On the other hand, a passive tag is devoid of any embedded battery and therefore is cheaper as well as smaller than an active tag. However, such a tag needs to be illuminated strongly by radio energy to transmit a signal. Both these types of tags can be read-only type, WORM type or read-write type. A read-only tag has a preloaded and assigned virtual number that acts as a key to the database. This tag is programmed by the manufacturer and cannot be re-written. WORM (Write-Once-Read-Many) tag, on contrary is considered as a blank tag and is programmed with an electronic product by the user. This kind of a tag can be written by the user but only once. In addition, there is read-write tag as well that is being preferred in most of the libraries because of their ability to be rewritten by the system users. All these types of tag are visible to the reader, and thereby have revolutionized the collection management in libraries. They have eased the transactions and have also decreased the material handling time as well. They have encouraged the use of convenient self service stations and have made security of resources a possible phenomenon. In addition, these tags have saved the time of users and reduced repetition of tasks as well as waiting lines at the circulation counter. **Table 4.1** shows desired specifications of an RFID tag.

Specification	Value for a Library RFID tag
Size	101 x 50 x 0.4 mm
Inlay Type	Wet Adhesive
Colour	White

Frequency range	865-867 MHz
Read-rate	Less than 1 millisec
Read-range	5cm to 5m
Protocol	EPCglobal Gen2 (V1.2.0) and ISO/IEC 18000-6C
Technology	448-Bits of NVRAM
Security	Password protection

Table 4.1 specifications of an RFID tag

2. RFID patron smart card

RFID smart card also called a chip card or an integrated circuit card (CC or IC card), is a small plastic card, typically a wallet-sized or standard credit card sized, embedded with a chip. The role of the chip is to connect with the security device that requires the cardholder's verification of authenticity. If an RFID tag is required as a transponder to receive, store and transmit data through radio waves, then RFID card is distinguished with its obvious physical characteristics and for specific applications. The base material in the manufacturing of most of the RFID cards is a plastic polymer called Polyvinyl Chloride (PVC). This polymer is the most commonly used plastic polymer owing to its durability, flexibility and versatility for card making. After PVC, Polyethylene Terephthalate (PET) is the most preferred plastic polymer for card makers. PET is also considered as a durable as well as heat resistant plastic polymer. However, the use of non-plastic cards like bio-plastics or wooden ones is considered to be the future of this technology, on sustainable environmental grounds. Higher cost of such cards has been the only limiting factor, yet scientists are trying to curb it as well. There are four categories of RFID cards based on the difference between frequencies.

1. Low Frequency at 125KHz RFID card, with a reading distance of 1-2cm.
2. High Frequency at 13.56MHz RFID card, with a reading distance of up to 10cm.
3. Ultra-High Frequency at 860-960MHz RFID card, with a reading distance of 1-20 meters.
4. Combination of two or even three different frequencies into a single RFID Card.

Every RFID card embeds with an antenna which remains connected with the RFID integrated circuit (IC). This circuit enables this card to receive, store and transmit data through radio waves. Like RFID tags, an RFID card usually uses passive RFID technology without an internal power source. The RFID card is activated by the electromagnetic energy received from RFID reader. Table 4.2 shows general specifications of an RFID smart card.

Specification	Value for a Library RFID card
Dimensions	86mm ×54mm ×0.8mm (L×W×H)
Colour	White
Material	PVC
Working frequency	860MHz-960MHz
Communication Protocol	ISO/IEC 18000-6C(EPC Class 1 Gen 2)
Working Mode	FHSS fixed frequency transceiver
Working R/W	Read-Write
Reading Range	30cm to 7meters
Writing range	5cm to 5meters
Operation temperature	-25 ℃~+65℃
Storage Temperature	40℃~+85℃
Read-write endurance	1,00,000 times

Data retention	10years

Table 4.2: general specifications of an RFID smart card

3. RFID smart card reader

A radio frequency identification smart card reader (RFID reader) is a small device used to activate an RFID smart card. The equipment is also used to store the data or virtual transaction number into an RFID smart card. This virtual number is then used to identify, categorize, track any assets, objects or book in a library set up. RFID smart card reader, when connected with the server via integration module software helps in identifying objects faster, more precisely and at a reduced resource utilization. RFID card readers are used in many formats and forms, depending upon the requirement, like Fixed Reader, RFID Mobile Reader, USB RFID Reader, Desktop RFID Reader, HF Card Reader, etc. In libraries, the most commonly used smart card readers are USB and Desktop card readers, owing to their close proximity with the overall RFID system available in a library. Like RFID tags, RFID smart cards are categorized into two classes: active card reader and passive card reader. An active RFID card reader comes with an inbuilt battery that is cable of transmitting interrogator signals on its own, while as a passive RFID smart card is devoid of any internal battery and receives radio signals from an RFID tag. Depending upon the kind of RFID tag and RFID reader used, an RFID system can be of three types:

1. **Passive Reader Active Tag** (**PRAT**)
   In this kind of an RFID system, RFID reader is in passive format that only receives radio signals from a battery operated active tags. The reception range of a PRAT system reader can be adjusted from 1–2,000 feet (0–600 m), thereby allowing flexibility in applications such as protection and supervision of assets.
2. **Active Reader Passive Tag** (**ARPT**)
   This system has an active reader, capable of transmitting interrogator signals and also receives authentication replies from passive tags.
3. **Active Reader Active Tag** (**ARAT**)
   This system uses both RFID tags as well as RFID card reader in active form. The tag is activated with an interrogator signal, which is received from the active reader.

An RFID card reader not only helps in feeding the data into an RFID smart card but also helps in activation of the tag embedded in the card. The activated card is later on used by the patrons to enter into the library premises and to complete the self service (check-in/check-out processes). Table 4.3 shows general specifications of an RFID card reader.

Specification	Value for a Library RFID card reader
Material	ABS
Colour	White
Operating Frequency	13.56 MHz
Standard Protocol	ISO 14443AISO 15693
Dimensions	104mm x 63mm x 15mm

Table 4.3 shows general specifications of an RFID card reader

4. Integration module software (IMS)

The successfulness of the RFID system is predominantly because of its ability to coalesce with the existing system in a library setup. In addition, RFID equipments including readers,

check-in/check-out KIOSKS, staff station cannot work independently and need to integrate with the system database via software module. This purpose of integration is made possible by the presence of Integration module software that integrates the existing service systems like pre-operational integrated library management software (ILMS) or any other database with the RFID equipments and hardware. The flexibility of the IMS module provides an interactive interface that easily embeds different types of pre-existing systems with the RFID system. For this purpose, the software designers make sure that the structure of IMS co-relates with the existing software as well as hardware. The most common pathway followed for integration is by adapting a simple circuit with simple integration control or action. In this mechanism, a signal from any reader is transformed into a virtual code by the IMS, which is understood and read by the existing ILMS. In other words, the reader of the RFID system provides only an electric wire for signal transmission and thereby acts as a signal sender. The response from the database is depicted by the RFID equipments by means of an interactive interface. Although, the fundamental job of an integration module is to extract data from the RFID tags and managing data flow to the backend, but it also performs the functions of basic filtering, reader integration and reader control as well. In a simplified manner, integration software or integration module software (IMS) helps in retrieving data from readers, filtering data feeds to application software and in generating inventory movement notifications. In addition, it assists in monitoring network performance of tags and readers, capturing history of transactions and analysing tag-read events for application tuning and optimization.

5. Server

Server is an important component and is considered as the soul of RFID system by many experts. This is mainly because the efficiency of entire RFID system is determined by the capability of the server. It plays the role of communication gateway among the various components that are connected within the system. It not only receives the information from different readers like card reader, staff station etc but also exchanges the required information between the interfaces and the databases. Software like Applications Programming Interface (API), Session Initiation Protocol (SIP/SIP2) and National Circulation Interchange Protocol (NCIP) are essential to interface it with the integrated library management software (ILMS) and to run an RFID based automated library. Typically, the server includes a transaction database so that the reports can be generated. For an RFID system, a high end server is recommended for smoother operations. The specifications can be selective in nature, depending upon the requirement and budget. A typical specification chart has been given in table 4.5

6. Staff Station

Staff work station or simply staff station is an integrated RFID appliance with multiple features and functions. It is a primarily a staff assisted station which is used for programming of new documents (having RFID tags attached). The device can also be used for document sorting and for charging-discharging documents whenever there is a need to use an additional check-in/check-out appliance. Structurally, it consists of radio frequency module, a control unit and an antenna. When a new document is supposed to be programmed, it is first embedded with an RFID tag. The document is then placed on the staff station to be programmed by using the accession number of that particular document. Once programmed or activated, the antitheft function of the system is also put in operational mode. The station can be placed anywhere in the system and helps in identifying the documents that have or haven't been entered in the integrated library management software (ILMS). Staff work station has been designed in such a manner that it allows an efficient and effective conversion

of the collection from existing barcodes to RFID tags. In another words, it transforms the data stored in the form of barcodes into the memory of the tag. However, if required, it can also be used in parallel with the barcode as well. A typical staff station is small in size and can be used in any library desktop with normal configuration. Table 5.6 highlights some important specifications of a staff station

Specification	Value for a Server
Chassis	3.5" Chassis with up to 4 Cabled Hard Drives
Processor	Intel Xeon E-2334 3.4GHz, 8M Cache, 4C/8T, Turbo (65W), 3200 MT/s
Processor Thermal Configuration	80W or less
Memory DIMM Type and Speed	8GB UDIMM, 3200MT/s, ECC
Hard Drive	1TB Hard Drive SATA 6Gbps 7.2K 512n 3.5in Cabled
Advanced System Configurations	UEFI BIOS Boot Mode with GPT Partition
Motherboard	Power Edge R250 Motherboard with Broadcom 5720 Dual Port 1Gb On-Board LOM, V2
Network card	Ethernet port
Bazel	Standard

Table 4.5: Specifications of a common server

Specification	Value for a Staff work station
Material	ABS plastic
Memory	128 – 256 MB
Dimensions	450mm x 450mm x 60mm
Operating frequency	865-867 Mhz
Protocol	ISO 18000-6C: EPC Class1 Gen2
Interface	Ethernet, USB powered
Range	50 cm

Table 5.6: Specifications of a staff station

7. Self Check-in KIOSK

A KIOSK is an interactive computer terminal with specialized hardware and software, used as a tool to provide access to information in varied fields like communication, commerce, education etc. The utility and usefulness of these KIOSKs has been accepted widely and is being embraced by retail, hospitality, foodservice and other sectors to smoothen their line of action and to improve their customer services. These are mostly preferred in zones with high footfall or units having high customer base. In libraries, a Self Check-in KIOSK or station is an interactive Graphical User Interface (GUI) computer with a touch screen and two in-built RFID readers. The two readers include a staff station and a card reader that are meant for

specific purposes. The integration software enables a KIOSK to interact and extract data from integrated library management software (ILMS). The software also helps it in personal identification, document handling and circulation process. A self check-in KIOSK helps library users to check-in (issue) their books on their own without any interference of the staff. In a library environment, which experiences a high foot fall and has a limited staff, the use of such KIOSK is a boon. In addition, patrons can also use this KIOSK in check-out (return) process (optionally) and in monitoring their library accounts. Being an interactive interface with touch screen, users can easily complete the entire transaction process in limited time span and with limited efforts. With the advent of RFID KIOSKs, the check-in has become very fast and efficient. Each KIOSK can process up to 10 items simultaneously. The two readers available in the KIOSK are meant to read the tagged books and smart cards respectively. As a result, completes the process of patron identification and book marking simultaneously and concurrently. This component of RFID system not only helps in saving the resources and efforts in a library but also reduces queuing and enhances user satisfaction. Table 5.7 shows major specifications of KIOSK.

Specification	Value for a Self check-in KIOSK
User Interface	Graphical
Readers	Dual (staff station for books and card reader)
Screen	All in one touch (21 inch) Screen CPU
HDD	5000GB
RAM	2 GB
Operating frequency	13.56 Mhz
Connection	LMS via SIP or NCIP commands
Printer	Embedded for issue-receipts/thermal slips

Table 5.7: Major specifications of self check-in KIOSK

8. Self Check-out KIOSK

A self check-out KIOSK, like self check-in KIOSK is also an interactive Graphical User Interface (GUI) computer with a touch screen and having two in-built RFID readers. The readers in this KIOSK include a staff station that reads the RFID chip embedded in a book and a card reader for user authentication. This KIOSK is also known as "the book drop system" as it consists an attached book drop box to store the books after being returned by the patrons. The stored and collected books are then returned to their respective locations by the library staff. The device is also equipped with a printer to generate receiving receipts to the users. The receipts are then collected and checked by the library janitors for proper record keeping. The main job of this KIOSK, as suggested by the name, is to It allow patrons to automatically return the library documents. The presence of a drop box enables patrons to automatically drop off the documents without ant staff intervention. The interaction and extraction of data by this KIOSK from a central database is made possible by the presence of integration module or integration software. This software acts as a link between the device readers and the ILMS configured within the system. The presence of this equipment, like other readers within the RFID system, has improved the efficiency of the in-house operations and has also enhanced the overall transaction speeds. This equipment automatically checks-out the document, takes them off the patron's library account and reactivates the security function of the system. It has undoubtedly helped in saving the library resources and staff efforts in managing the library operations. Table 5.8 shows major specifications of KIOSK.

Specification	Value for a Self check-in KIOSK
User Interface	Graphical
Readers	Staff station with PAD Antenna for quick book detection
Screen	All in one touch (21 inch) Screen CPU
HDD	5000GB
RAM	2 GB
Operating frequency	13.56 Mhz
Connection	LMS via SIP or NCIP commands
Printer	Embedded for return-receipts/thermal slips
Drop book cushion	Up to 200 books
Receiving Cart	book tray RFID sensor
Client	335,112.00 16

Table 5.8: Major specifications of self check-out KIOSK

9. Security Gate System

Security gate in RFID system is an Electronic Article Surveillance (EAS) meant to ensure security of library resources. This equipment is used as an anti-theft system and to identify any unissued item by libraries. Consequently, plays a crucial role in detecting unborrowed or improperly checked-out library document or item. This detection is made possible by the presence of an integral chip within the RFID tag which remains embedded within the document or item. In this way, an RFID tag performs the functions of item identification as well as theft detection. RFID gates have been used since early 1990s in different sectors for theft detection. The design used in libraries has been modified by merging RFID with antitheft functions into a single device, thereby enhancing the overall security system within the premises that too without any human interference. An RFID security gate consists of two pedestals of equal dimensions. However, to increase the detection surface area, an additional pedestal can also be added. It is a standalone device that remains plugged to the main power supply. A security gate is FCC/CE compliant and its design meets the defined CE/UL/FCC norms. Owing to its standalone nature, an RFID security gate operates even when integrated library management software/system (ILMS) is down or under maintenance. This device can work independently without being attached to the network or library database. The security system in a library allows a user-admin to execute multiple read-write operations as well as activation-deactivation of tags simultaneously. These security gates are modern library collection keepers and are run by comprehensive algorithms for proper alarm as well as detection of unborrowed items. As soon as a non-deactivated items passes through these gates, an audible and visual signal detects its presence instantaneously. This system is considered as one of the low cost security systems that just require a tag and a detection device. Table 5.9 shows prominent specifications of such a gate.

Specification	Value for RFID security gate
Material	Industrial Acrylic
Colour	White/transparent
Power supply consumption	AC 230V & 60W max
Dimensions	1680mm x 550mm x 30mm

Operating frequency	13.56 MHz
Protocols	ISO 15693:ICODE
Communication	Ethernet
Range	48-50 inches

Table 5.9: Specifications of RFID security gate.

10. UHF Hand held reader

UHF Handheld reader is a portable inventory reader loaded with android platform and having options of WLAN, Bluetooth and Barcode. It works at a standard frequency of 13.56 MHz. This portable reader is also known as inventory wand as it can be moved across the book shelves to capture the data stored within the embedded RFID tags. The process of data capturing is completed without even touching the books or tags. The captured data is directly transferred to a storage unit, which can be checked at the server. In addition, the reader can directly be connected with a pocket PC, where captured data can be stored and later can also be transferred to the server. In a simplified manner, an RFID hand held reader performs four main functions in a library:

(a) Helps in recording complete book collection or stock of a library.
(b) Assists in stock verification.
(c) Guides in rectification of wrongly shelved books.
(d) Helps in searching of requested book or document.

RFID handheld reader performs inventory checks at a faster rate with accuracy. The performance of this device largely depends on its long and light weight handle that consist of an RFID antenna. This antenna rotates to facilitate the identification of items on the shelves. When passed over the tagged items, the reader captures data instantaneously, irrespective of document thickness and proximity from the shelf edge. Handheld reader has a unique shape and its functions help library staff not only in identifying the items but also in re-shelving, weeding and on-hold processes. In addition, this reader proves very effective and helpful for the library staff, as the processes of inventory control, document identification etc can be done without unshelving the books from their respective shelves. With the help of such a reader, the inventory check no longer can be considered as a tedious and unvaried activity. The stored and captured data in the form of a data packet on pocket PC or server can be utilized for various purposes. Table 5.10 highlights some prominent specifications of this reader.

Specification	Value for RFID handheld device
Material	ABS plastic
Screen	3.2 inch touch screen
Storage memory	1 GB flash; 10 GB internal (32 GB expandable)
Dimensions	195mm x 100mm x 150mm
Operating frequency	13.56 MHz
Protocol	ISO 15693: ICODE
Communication Interface	USB/WLAN/Bluetooth
Range	Up to 30 cm
Battery	4000 mAH; inbuilt and rechargeable
Processor	533Z

Table 5.10: Prominent specifications of RFID handheld reader

Optional items-

Apart from items and equipments mentioned in precious sections, there are two more elements that complete an RFID system in a library set up:

(a) PVC card printer: meant for printing RFID smart cards.
(b) Institutional labels: meant to hide the RFID tags that are embedded in a book.

Advantages of RFID technology in libraries

The use of barcode technology is considered as a stepping stone in transforming the traditional libraries into the modern IT based institutions. However, certain limitations in this design paved a way for the implementation of better and more comprehensive system in the form of RFID technology. The line-of-sight transaction, no security advantage and no collection management provision forced libraries across the globe to shift from barcode to a newer technology without such constraints. In addition a need was felt to have a better technology that can improve the circulation management, inventory and security of library collections. Altogether, these requirements paved a way for the introduction of RFID in libraries. The ease of operations, flexibility of usage, and reliability of system are the essential features that are associated with RFID. The advantages of this new technology have been discussed below in detail.

New technology with potential

RFID is a contemporary technology with immense capability and stupendous potential. It has been used in multiple sectors and fields with success. The potential of tracking an asset and thereby providing a secure atmosphere in an institution or establishment is a guiding principal for its utility in modern times. In addition, management of inventory as well as collection is an added advantage that has helped this technology in securing more and more grounds or sectors. Rightly, this technology comes with immense potential and hence can be used with multiple applications in future, in libraries as well as other quarters.

Flexible technology

This technology bears maximum flexibility as a single unit of RFID tag can be used in parallel for data storage and identification as well as for asset security. Similarly, a single RFID card is used for data storage as well as member identification process as well. On equal grounds, a staff station is used for tag activation and can be flexible for issue-return process. While an issue KIOSK can run issue process as well as return process simultaneously, in absence of a return KIOSK. This system offers maximum flexibility in terms of equipment usage and equipment efficiency thereafter.

Reliable technology

The RFID technology is considered as a reliable and dependable technology. The efficiency of readers used in different equipments is claimed to be 100% by many vendors. The transfer of data from RFID to ILMS or transfer of an asset using an RFID reader into the account of a member on ILMS database has been verified by many studies. Similarly, detection of an unauthorized issue or detection of a theft has also been studied and verified by means various

analytical works. The crux of these investigations, deem this technology as a reliable and authentic one.

Comprehensive design

The design of this technology makes it a very comprehensive one for the use in library environment. It not only enables different devices to get connected with each other but also integrates the overall RFID system with the existing ILMS database in the library. The check-in/check-out processes and the inventory control are a result of extensive and exhaustive nature of this technology.

Automated material handling

The conveyor and the sorting systems in this technology help in sorting the material into different categories and subjects, that too without much human intervention. This reduces the efforts and time in shelving and re-shelving processes. In addition, the use of equipments in processes like stock verification and circulation also ensures less human intervention and more automated material handling.

Automatic reports

This feature of RFID technology helps in generating many reports axiomatically. These reports play an important role in overall library management and in shaping the future course of action for providing efficient services to users. Each equipment in RFID technology, apart from performing specific tasks, also stores many details that can be used to generate vital reports. For instance, an RFID based smart card carries member details and also holds data about fines and overdue. This data can be used to generate debit collection statistics. Other equipments also hold vital data and can be used to engender multiple report generation processes.

Labour saving

One of the major advantages of an automated system in any sector is that it helps in reducing the human efforts to perform a particular task. The saved labour can be utilized for other processes and projects in such an automated environment. RFID technology under similar grounds helps in eliminating the applied labour for document issue-return processes. The use of KIOSKs in this spectrum has helped in saving the time and efforts of a library. The automated stock rectification and stock verification by means of handheld readers have worked under similar grounds to save the labour as well efforts of human force working in a library.

Self charging-discharging

This implies the process of staff-less issue-return transaction with the aid of IT based equipments in an RFID environment. This technology helps users to get their items issued as well as returned through user-friendly graphical interfaces called KIOSK. This technology empowers a patron to enter the library premises independently to search relevant document, issue the document or return the document that too without having any interaction or dependency over library staff. The status of patron accounts (due date, number of items issued) can also be verified independently with the advent of this technology in a library.

Error free circulation

The error free or errorless circulation is one of the features of this technology. With vendors reporting 100% accuracy in circulation trials and investigations also figuring similar figures, the circulation process in this technology can be deemed as error free. Once installed successfully, educational institutions can have a trial period of few days to check the authenticity and accuracy of data transfer from RFID to ILMS during circulation and other processes.

User friendly

From the prism of patrons and users, this technology provides an easy and user friendly interface to complete the library transactions. It helps them in searching the desired document and then issuing-returning the same in a staff-less environment. The technology is easy to use and being a graphical interface can be counted as user friendly as well

Improves staff productivity

Being an efficient system, this technology helps in completing the tasks of database compilation, inventory management and stock verification in a prompt manner. Not just that, since RFID is capable of providing a staff-less circulation or staff-less transaction in a smoother manner. The human resources can be utilized to support other works and assignments in a library. Consequently, helps in improving the staff productivity in an institution or library.

Easy theft detection

One of the most phenomenal features of RFID based technology in any system is its ability to detect thefts and unauthorized transactions. When this system is in working state and a user takes or tries to take an asset (book etc) without proper authentication, the security gate detects such an asset automatically and thereby alarms an alert sound. This has helped libraries and institutions to protect and secure their assets from such mishandlings and losses. The ability to detect thefts and unauthorized transactions has helped this technology to improve the footings in multiple sectors.

Web interface provision

The WEB-OPAC facility in RFID provides an option to the users to check the library catalogue from anywhere via internet facility. The provision also allows patrons to check different parameters in their respective accounts like due date-issue date of charged items along with other details that too using a smart phone at their respective native places. The feature has removed many hurdles and obstacles in creating a barrier-less patron-library interaction and environment.

Better range

RFID technology has much better detection range than other contemporary technologies. An RFID tag can be read from a greater distances while a reader can fetch the information from a distant tag or chip. This is one of the many important features that has forced libraries to shift from barcode to RFID. The better range of a security gate has ensured sideway detection of unauthorized transactions and theft discernments.

Collection management

Collection management is the area of librarianship that incorporates the variety of operations involved in selecting, acquiring, storing and maintaining collections in a cost-effective

manner. RFID has helped in streamlining the collection management policy of a library. The faster and less laborious collection monitoring as well as sorting by means of different RFID devices has been a revelation in managing and controlling the overall collection of a library.

High speed inventory

The ability of this system to scan books and assets through a wireless medium is a unique advantage that is associated with it. In this process, a tagged item can be scanned or read even without tipping them out or removing them from their respective positions. A handheld reader is moved across a shelf containing items or books in order to read the unique identification number stored in their tags. By this method, inventory can be not only checked in a faster manner but can also be sorted in a proper order that too without wasting much human power.

More resistant technology

The tags used in RFID are more resistant than barcode and can withstand many extreme conditions. They have a longer lifespan and many manufacturers claim that such tags can undergo transactions up to 100000 times before requiring to be replaced. The other equipments including KIOSKs, readers and others can also withstand temper as well as paramount state.

Avoids work repetition

RFID avoids the repetition of tasks including stock verification by creating a database of captured data via RFID handheld device. The database can be used to know the current collection, issued collection or missed collection. Similarly, the repetitive issue-return process, involving much of the library staff, is also avoided by this technology. The saved human resources can be utilized to guide the users or to perform some other developmental tasks in a library or institution.

Real time database updation

The updation of books/stock in RFID based environment takes place in real time basis. Consequently, a patron can get an exact view about the status of collection or the availability of a particular document. Since the time consumption in inventory check is very less and chances of a change in collection pattern is very low, there is every possibility of acquiring the correct and actual database status through real time analysis. In addition, the patron account monitoring, bibliographic enquiry and transaction analysis through a WEB-OPAC, get updated on real time basis while using this technology.

No line-of-sight action required

In a system with barcode technology, the transaction can be made possible only through a line-of-sight action. However, in RFID technology there is no need for a line-of-sight action as transactions can be completed without any staff interference. The availability of self service in the form of issue KIOSK and return KIOSK has ensured that no staff personal is required to charge or discharge an item/book in a library. A patron, on its own, can locate a required piece of information and can also issue-return it through an easy to use graphical interface, thereby eliminating any requirement of a line-of-action.

More memory

RFID tags possess more memory than barcodes and hence can store more data about an item. The capacity in a barcode enables it to store only few details like unique virtual number etc. On contrarily, an RFID incorporates an extra rewriteable space that is used to store additional data about the item or book. This additional data helps in differentiating two similar items having few common variables. The additional space is advantageous for the benefit and better tracking of an item or book. In addition, the readers used in different applications of RFID system, have extra memory to work more efficiently and systematically. The availability of extra memory in RFID handheld reader makes inventory check of larger institutions or library a possibility, while extra memory in KIOSKs help them to work in real time basis without any time lapse.

Allows multiprocessing

An RFID allows multiple processes to work and complete simultaneously. Library can activate RFID book tags using a staff station and simultaneously can also activate smart cards using a card reader. The circulation service can run simultaneously while staff can be involved in many tasks like stock rectification etc. Similarly, a user can issue as well as return two separate documents using two separate KIOSKs simultaneously as well. These multiple processes can be governed and controlled only in presence of a sophisticated automation system like RFID.

Easy searching of material

The searching of a particular document can be done using OPAC facility by a student. However, for library staff, the searching, sorting and rectification of library material can be done using a handheld reader. The scanning by this device creates a list of available documents in real time basis, without dragging the material out of the shelves. Hence searching of an item becomes easy and quick.

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