

RFID, Components, Benefits and their application of Libraries in Digital Era

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Abstract:

RFID (Radio Frequency Identification) is a form of wireless communication that incorporates the use of electromagnetic or electrostatic coupling in the radio frequency portion of the electromagnetic spectrum to uniquely identify an object, animal or person. RFID library management, using RFID tags library, is easy and convenient with many benefits, but cost is a big challenge for its adoption. Currently RFID is most important technology for library automations used for Tagging books, ID card, Stack verifications, Self-Checking of books also gate keeper for stolen books from users etc. This paper is mainly covers RFID meaning, Features, components, benefits, disadvantages applications and suppliers and so on in details.

Keywords: RFID, Components, Library, Applications, Benefits.

1. Introduction:

RFID is an auto Identification Technology which is used for tracking items with a tag on it which sends data to readers through radio waves. These tags makes the item to speak about its identity, activity, location and data stored inside through readers and finally to the application software to make the information useful. RFID is one of the most technologies being adopted by both industry and academic world. Modern academic library is a place where millions of books advanced, periodicals, CDs, DVDs and other electronic reading materials are contained. It is a challenge to manage for librarians, managing such type of huge collection. A RFID library management system consists of books, each attached with an RFID tag, RFID reader, computer network and software. Library staff handle lending, returning, sorting, tagging etc. of books, using RFID tags in this library system. A person can locate RFID library books marked with a RFID tags, using the RFID reader which identifies and locates the book. When the book is carried to the counter, the library staff can either activate or deactivate the electronic article surveillance bit in the book's tag. If a book is borrowed, then the surveillance bit is deactivated.

1.1.Features of RFID:

- Able to Read and Write data without direct contact. ...
- By "combining an item with its information", a highly pliable and reliable system configuration becomes possible. ...
- Can simultaneously access information of multiple RF tags
- Reading and writing is possible without line of sight, using electric and electromagnetic wave transmission
- With the adoption of space transmission technology and protocols, highly reliable communication is made possible.

1.2.What is RFID?

Radio-frequency identification (RFID) uses a wireless radio system to transfer data from a tag attached to an object, such as a book, so you can identify it and track its use. The tag contains electronically stored information on a microchip which is read by a RFID reader or scanner.

1.3.How does a RFID work?

RFID tags are affixed to items in order to track them using an RFID reader and antenna. RFID tags transmit data about an item through radio waves to the antenna/reader combination. ... When the tag receives the transmission from the reader/antenna, the energy runs through the internal antenna to the tag's chip.

1.4.What is RFID used for?

These radio waves transmit data from the tag to a reader, which then transmits the information to an RFID computer program. RFID tags are frequently used for merchandise, but they can also be used to track vehicles, pets, and even patients with Alzheimer's disease. An RFID tag may also be called an RFID chip.

1.5.What is library security system?

Library Security System. ... RFID (Radio Frequency Identification) allows an item, for example a library book, to be tracked and communicated with by radio waves. This technology is similar in concept to a cellphone. RFID is a broad term for technologies that use radio waves to automatically identify people or objects.

1.6.How do library RFID tags work?

Radio-frequency identification (RFID) uses a wireless radio system to transfer data from a tag attached to an object, such as a book, so you can identify it and track its use. The tag contains electronically stored information on a microchip which is read by a RFID reader or scanner.

2. Components of RFID System:

2.1. Reader:

The RFID Reader, which is also widely known as interrogator, sends RF signal to request tag for transmitting information within the chip. The response received from the tag is then translated in to digital form and send to the application software. Different types of readers are fixed readers, handheld readers, network readers, readers embedded in other mobile devices etc.

2.2. Antenna:

The antenna transmits an electromagnetic field, which activates the tag. The antenna also receives the data from the tag and sends it to the reader. RFID tag also has an antenna, which receives the required power from the electromagnetic field, and transmits the data. Tags also require an antenna to transmit the information to the reader and to receive information from the reader if it is a rewritable tag.

2.3. Tag:

The tag is made up of a microchip with the unique identification number and the antenna to be able to transmit this data to the reader wirelessly. RFID tags have high data capacity and can include manufacturer, batch no., ownership, destination, history etc. depending on the application needs. The amount of storage available on the tag ranges from 16 bits to as high as several thousand bits. There are three types of encoding available in tags i.e. Read only, write once, and re-writable tags.

2.3.1. Active and Passive Tags:

Passive tags are battery less and transmit data only when energized by the reader. Active tags are able to transmit data using their own battery power. Read ranges are more for active tags than for passive tags but

are costlier for their extra capability. Therefore active tags are used for high value items and for longer reading distance.

3. Types of RFID Systems:

3.1.Active RFID system: These are systems where the tag has its own power source like any external power supply unit or a battery. The only constraint being the life time of the power devices. These systems can be used for larger distances and to track high value goods like vehicles.

3.2.Passive RFID system: These are systems where the tag gets power through the transfer of power from a reader antenna to the tag antenna. They are used for short range transmission.

4. What type of Libraries use RFID Solutions?

The most common libraries that use bibliotheca RFID solutions around the world are those with the following goals and characteristics.

- Libraries looking to improve the overall customer experience
- Libraries interested in improving the workflow and movement of materials
- Libraries focused on inventory and collection management solutions
- Libraries looking to streamline high circulation activities
- Libraries who are focused on reducing staff time needed for materials handling

4.1. Application Software:

It is enterprise software which finally uses the data captured by the readers and uses the information to provide real-time visibility to the process. In some cases RFID middleware is developed which lies between the hardware infrastructure and the software application as a common interface which manages data flow between the two and manages the hardware infrastructure.

4.2. RFID Frequencies:

4.2.1. Low Frequency (LF) RFID:

- The LF band covers frequencies from 30 KHz to 300 KHz. Typically LF RFID systems operate at 125 KHz, although there are some that operate at 134 KHz. This frequency band provides a short read range of 10 cm, and has slower read speed than the higher frequencies, but is not very sensitive to radio wave interference.
- LF RFID applications include access control and livestock tracking.
- Standards for LF animal-tracking systems are defined in ISO 14223, and ISO/IEC 18000-2. The LF spectrum is not considered a truly global application because of slight differences in frequency and power levels throughout the world.

4.2.2. High-Frequency (HF) RFID:

- The HF band ranges from 3 to 30 MHz. Most HF RFID systems operate at 13.56 MHz with read ranges between 10 cm and 1 m. HF systems experience moderate sensitivity to interference.
- HF RFID is commonly used for ticketing, payment, and data transfer applications.
- There are several HF RFID standards in place, such as the ISO 15693 standard for tracking items, and the ECMA-340 and ISO/IEC 18092 standards for Near Field Communication (NFC), a short range technology that is commonly used for data exchange between devices. Other HF standards include the ISO/IEC 14443 A and ISO/IEC 14443 standards for MIFARE technology, which used in smart cards and proximity cards, and the JIS X 6319-4 for FeliCa, which is a smart card system commonly used in electronic money cards.

4.2.3. Ultra-high frequency (UHF) RFID:

The UHF frequency band covers the range from 300 MHz to 3 GHz. RAIN RFID systems comply with the UHF Gen2 standard and use the 860 to 960 MHz band. While there is some variance in frequency from region to region, RAIN RFID systems in most countries operate between 900 and 915 MHz

4.3.Table.1. Frequency Charts:

Frequency	Characteristics	Applications
125 KHz – 135 KHz Low Frequency	<ul style="list-style-type: none"> ❖ Good performance around metal and liquid ❖ Slow data transfer rate ❖ Few inches of read range 	<ul style="list-style-type: none"> ❖ Access control ❖ Animal identification
13.56 MHz High Frequency	<ul style="list-style-type: none"> ❖ Worldwide standards ❖ Longer read ranges than LF ❖ Tag cost lower than LF ❖ Poor performance around metal and liquid 	<ul style="list-style-type: none"> ❖ Library ❖ Access control ❖ Asset tracking ❖ Smart shelf ❖ People identification ❖ Item level tracking
433MHz and 860MHz to 930 MHz Ultra High Frequency	<ul style="list-style-type: none"> ❖ Longer read ranges than HF ❖ Used as Active RFID systems ❖ Most widely accepted frequency in supply chain mandates ❖ Volumes may bring the tag cost to lowest when compared to others ❖ Poor performance when near metal and liquid 	<ul style="list-style-type: none"> ❖ Supply chain management ❖ Inventory control ❖ Warehouse management ❖ Logistics ❖ Asset tracking
2.45 GHz and 5.8 GHz	<ul style="list-style-type: none"> ❖ Fast data transfer rates ❖ Used for active and semi active RFID systems ❖ Poor performance when brought near metal and liquid 	<ul style="list-style-type: none"> ❖ Toll collection ❖ Industrial automation ❖ Fast moving conveyor belts

4.4.Table 2. Standards:

Standard	Frequencies	Subject of the Standard
EPC Class 0	860 - 930 MHz	Parameters for air interface communication
EPC Class 1	860 - 930 MHz	Parameters for air interface communication
EPCglobal Gen 2	860 - 930 MHz	Parameters for air interface communication to replace Class 0 and Class 1
ISO 14443	13.56 MHz	Regulation for contactless / proximity ID cards
ISO 15693	13.56 MHz	Regulation of contactless / vicinity cards, reading distance up to 1 m.
ISO 18000-2	125, 134.2 KHz	Low Frequency RFID air interference protocol
ISO 18000-3	13.56 MHz	Reading distance max. 1.5 m, improvement on ISO 15693
ISO 18000-4	2.45 GHz	Microwave

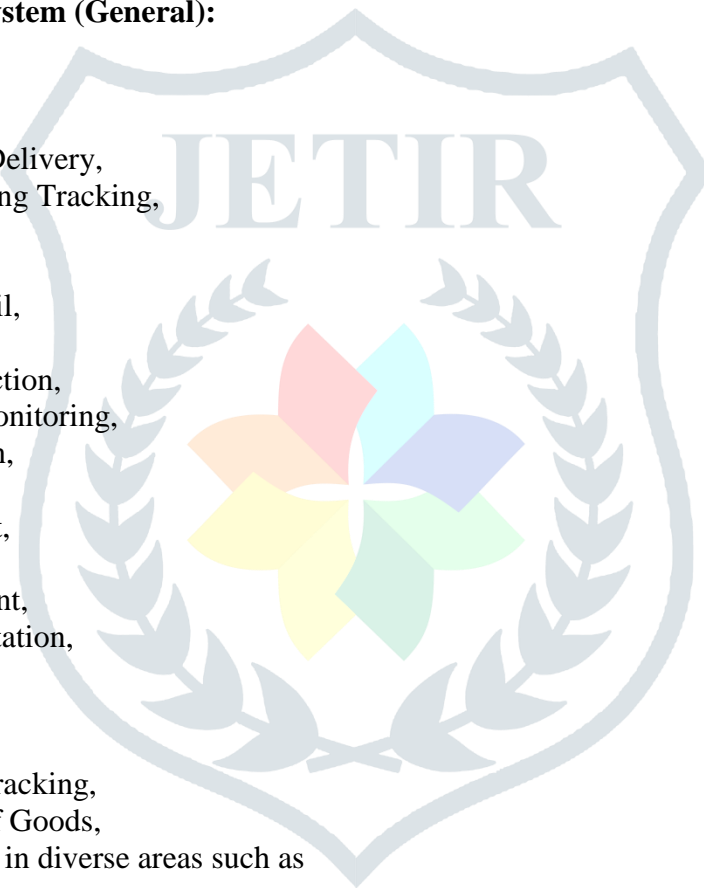
ISO 18000-5	5,8 GHz	
ISO 18000-6	860 – 960 MHz	EPCglobal Generation 2 Tags (submitted by EPC to ISO, under development phase)

5. Application in RFID Library Management System:

- Book Drops
- RFID Transponder or Tagging
- Counter
- The Patron self-check-out station
- Shelf Management
- Anti-theft Detection

5.1. Application in RFID System (General):

- Access Control,
- Asset Tracking,
- Automated Proof of Delivery,
- Boarding/Disembarking Tracking,
- Cargo Tracking,
- Club Management,
- Distribution and Retail,
- Document Tracking,
- Electronic Toll Collection,
- Fuel Consumption Monitoring,
- Inventory Verification,
- Kiosk Ordering,
- Laundry Management,
- Library Management,
- Livestock Management,
- Mining Ore Transportation,
- Parking Management,
- Personnel Tracking,
- Product Security,
- Production Process Tracking,
- Real-time Location of Goods,
- RFID based solutions in diverse areas such as
- Smart Cards,
- Student Tracking,
- Supply Chain Management,
- Targeted Marketing
- Truck Dispatch Management,
- Vehicle Tracking,
- Visitor Management,
- Warehouse Management,



5.2. RFID Library Workflow:

- Tagging of Books
- Self-check KIOSK
- Shelf Management
 - ❖ For stock verification
 - ❖ For searching a book
- Anti-Theft Detection
- Book Drop Box/Station

5.3. Basic Tasks in Library Management:

- Planning the acquisition of materials
- Negotiating borrowing materials from other libraries
- Selection of library materials
- Stacks maintenance
- Fee collection in proper way
- Membership management
- Responding to challenges
- Approving and designing events
- Fundraising

5.4. Why RFID for Libraries?

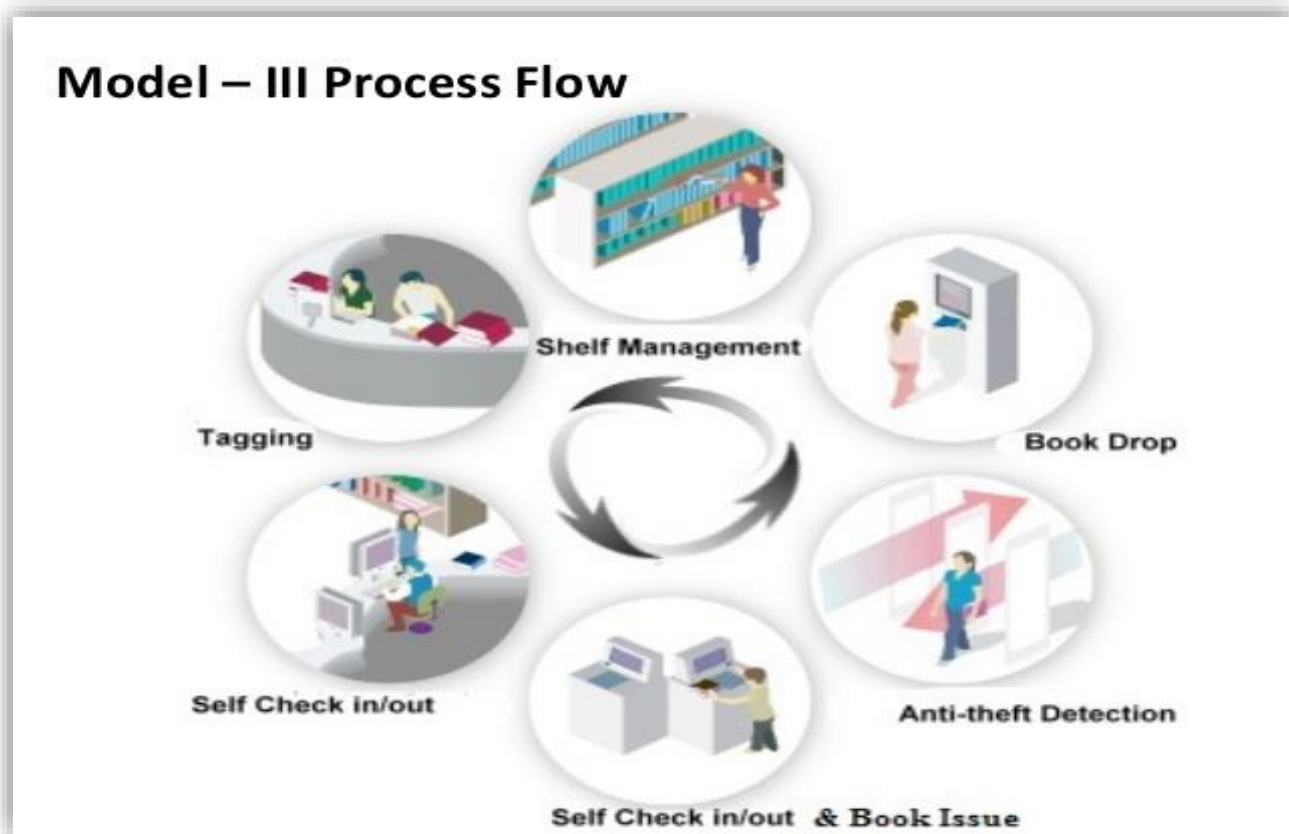
- Automated material handling
- Can help prevent theft
- Efficient Book circulation & management
- Faster Check-in / Check-out
- Fastest, easiest, most efficient way to track, locate & manage library materials
- Library inventory tracking in minutes instead of hours
- Longevity of Tags – Shelf life equivalent to the Book
- Multiple books can be read simultaneously
- Reduces Staff stress and increases management efficiency
- Unique ID of the RFID tag prevents counterfeiting

5.5. RFID for Libraries – Proposed Models:

Blaze proposes three variants for implementation of RFID for Libraries. They are;

- **Model -I:** Basic RFID implementation for Small and Medium Libraries
- **Model -II:** Advanced RFID based Library Management System for Medium sized Libraries
- **Model-III:** Advanced RFID based LBMS with Security and Surveillance for Modern Large size Libraries

5.6. Figure.1. Model Process Flow:



6. Advantages, Benefits and Disadvantages of RFID in Libraries:

6.1. Advantages of RFID in Libraries:

- Ability to manage the expenses over a number of years.
- Ability to write data
- Automated issue/return
- Automated materials handling
- Automated sorting of books on return
- Barcode scanners have repeatedly failed in providing security to books and journals in libraries. But nowadays, RFID tags are placed inside the books and an alarm is installed at the exit doors.
- Can read multiple item
- Contactless
- Easy stock verification
- External Book Return
- Faster Circulation
- High data storage capacity
- High level of security
- Improved Production planning
- Improved read range
- Improved tracking of high value items
- Inventory visibility accuracy and efficiency
- It would be a highly secured and authenticated system.
- It would be an easy and convenient system.
- Longevity of Tag life
- Mis-shelve easy identification
- No human intervention
- No line of sight

- Reduce materials cost and handling
- Reduce Shrinkage errors
- Reduction in workplace injuries
- Reliability
- RFID tags are very simple to install/inject inside the body of animals, thus helping to keep a track on them. This is useful in animal husbandry and on poultry farms.
- RFID technology is better than bar codes as it cannot be easily replicated and therefore, it increases the security of the product.
- Self-charging discharging
- Streamlined Inventory Management
- Suitable for harsh environment
- Technology standards to drive down cost
- The RFID tags can store data up to 2 KB whereas, the bar code has the ability to read just 10-12 digits.
- Theft reduction
- Time consumption would lessen as the system is fully automatic

6.2. Benefits of RFID use in Library:

- Ability to locate specific items
- Allow better accuracy in book collection management, resulting in reduced book purchase
- Assist inventory check with ease.
- Assist traceability of book allocation
- Easy book identification for shelving process
- Enhance book return processes by full automation of check-in, EAS activation and system updates completed simultaneously in the self-return chute
- Enhanced customer experience through fast and private self-check-outs
- Faster inventory process.
- Improves customer service
- Improves staff productivity
- Integrated security functionality
- Items can be placed on reader without careful placement that it is required for line of sight system (bar code scanner)
- More than one item can be checked out or checked in at the same time.
- reducing non-value added work processes
- Reduction of staff and patron time spent on finding items
- Reduction of staff manual processes, errors, and repetitive motion
- RFID improves library workflow by

6.3. Disadvantages of RFID in Libraries:

- As this system is completely automatic and does not require human control, it may be subjected to software failures at times.
- Chances of removal of exposed tags exit gate sensor problems
- Frequency Block
- High Cost
- Interoperability
- Reader collision
- Tag collision
- User Privacy concern
- With increasing number of racks, it would be difficult to sustain the cost of installation of an embedded system at each rack.

6.4.RFID Suppliers:

RFID suppliers are more in all over world given here such companies, they are;

- Alien
- Avery Dennison
- Bibliotheca
- FE Technologies
- Impinj
- InSync Software
- Lib-chip
- Library Plus
- Motorola
- Omni-ID
- RF Data Systems
- RFID4U
- Techlogic
- TIBCO
- Wave Trend
- Zebra

7. Dimensions of Service Quality:

- Accuracy
- Consistency
- Courtesy
- Knowledge of Employees
- Responsiveness
- Speed

7.1. Our Mission Should Be:

Based on above discussion and facts, Librarians need to re-orient and re-design their approaches and strategies to achieve the following objectives.

- Capture the Institutional best practices
- Create an institution's output
- Encourage open access
- Help libraries to meet the challenges of the digital world
- Increase an impact of research and development
- Manage learning materials
- Organize digitized collections and services
- Provide value added services to stakeholders
- Raise visibility/prestige of institution
- Utilization of information literacy

8. Conclusion:

RFID technology is not only emerging but also more effective, convenient and cost efficient technology in library security. This technology has slowly begun to replace the traditional bar-code on library items. The RFID tag can contain identifying information such as a book's title or material type, without having to be pointed to a separate. The information is read by an RFID reader, which replaces the standard barcode reader commonly found at a

library's circulation desk. The RFID tag found on library materials. It may replace or be added to the barcode, offering a different means of inventory management by the staff and self-service by the borrowed. It can also act as a security device, taking the place of the traditional electromagnetic security strip. And not only the books, but also the membership cards could be fitted with an RFID tag. The cost of the technology is main constraint.

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