

# Implementation of RFID Technology in Academic Libraries in India: Advantages, Challenges, and Recommendations

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## ABSTRACT

*The integration of Radio Frequency Identification (RFID) technology in academic libraries has revolutionized library operations by enhancing circulation efficiency, strengthening security, and simplifying inventory management. In India, the adoption of RFID has been gradual but impactful, with pioneering implementations at premier institutions such as IIT Delhi, IIM Calcutta, and Jadavpur University in West Bengal. This paper explores the major components of RFID systems—tags, readers, gates, kiosks, and software—and examines their role in transforming library services. It highlights the key advantages of RFID, including self-service facilities, rapid stock verification, and reduced staff workload, while also addressing challenges such as high costs, technical complexities, and privacy concerns. A comparative analysis of benefits and problems, supported by case studies from Indian libraries, provides a balanced perspective on the technology's current status. The paper concludes with recommendations for sustainable and inclusive adoption of RFID, emphasizing the need for government support, staff training, vendor-neutral systems, and user-centered design. By bridging the gap between traditional practices and modern technological innovations, RFID has the potential to redefine academic libraries in India as dynamic, smart, and future-ready knowledge hubs.*

**KEYWORDS:** RFID technology, academic libraries, library automation, circulation management, information security, inventory control, India, West Bengal, smart libraries, library modernization

## INTRODUCTION

Academic libraries in India are at a critical juncture, balancing traditional services with the growing demand for digital and automated solutions. Among the technologies transforming modern libraries, **Radio Frequency Identification (RFID)** stands out for its ability to enhance circulation, inventory, and security. RFID enables quick, contactless tracking of materials, reducing manual labor and improving efficiency.

Globally, academic libraries in the USA, UK, and Singapore have already integrated RFID into daily operations. In India, adoption began in the early 2000s, with institutions such as the **Indian Institute of Technology (IIT Delhi)**,

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Indian Institute of Management (IIM Calcutta), and University of Hyderabad leading the way. In West Bengal, RFID has been implemented at Presidency University, Jadavpur University Central Library, and some autonomous colleges, showcasing its gradual regional spread.

This paper examines the components of RFID systems, evaluates their advantages, highlights implementation challenges, provides examples from India, and offers recommendations for effective adoption in academic libraries.

### **1. RFID Technology in Libraries**

Library RFID systems typically use **High Frequency (HF) tags at 13.56 MHz**. Standards such as **ISO 15693** and **ISO 28560** ensure compatibility across vendors. A typical RFID setup integrates hardware, software, and protocols to automate library workflows.

#### *❖ Components of an RFID System in Libraries*

##### **A. RFID Tags (Labels/Chips)**

- Attached to each book or non-book material.
- Consist of an antenna and a microchip storing a unique identifier (UID) and sometimes bibliographic data.
- Commonly available as adhesive labels that can be placed inside book covers.
- Designed to work with HF (13.56 MHz) frequency and ISO standards for interoperability.

##### **B. Readers and Antennas**

- Devices that emit radio signals to communicate with RFID tags.
- Used in kiosks, handheld inventory devices, and security gates.
- Multi-tag reading capability allows several items to be scanned simultaneously.

##### **C. Self-Service Kiosks (Issue/Return Stations)**

- Enable patrons to borrow or return items independently.
- Integrated with the library's ILMS via protocols like SIP2 or NCIP.
- Reduce circulation desk congestion and promote user autonomy.

##### **D. Security Gates (Exit Sensors)**

- Installed at library exits to detect items that are not properly checked out.
- Often use dual antennas for maximum coverage and accuracy.
- Provide theft detection and collection security.

##### **E. Handheld Readers (Inventory/Wand Devices)**

- Portable scanners used for shelf-reading, locating misplaced books, and rapid inventory checks.
- Allow scanning of hundreds of items in minutes without removing them from shelves.

##### **F. Middleware and Server Software**

- Acts as a bridge between RFID hardware and the Integrated Library Management System (ILMS).
- Manages tag encoding, data exchange, and system logs.
- Supports standards such as SIP2/NCIP for smooth communication.

##### **G. Integrated Library Management System (ILMS)**

- Core library software (e.g., Koha, LibSys) that maintains the bibliographic database and circulation records.
- RFID integration enables real-time updating of borrowing/returning transactions.

## **2. Advantages of RFID in Academic Libraries**

The adoption of RFID in academic libraries provides multiple operational, managerial, and user-centric benefits. These advantages go beyond simple automation and help libraries reposition themselves as more user-friendly and technologically advanced service hubs.

### *a) Faster Circulation and Enhanced Self-Service*

One of the most significant benefits of RFID is the **speed of circulation transactions**. Unlike barcode systems, which require each item to be scanned individually, RFID allows multiple books to be issued or returned in a single operation. Patrons can simply place a stack of books on the self-service kiosk and complete the transaction within seconds. This reduces waiting times, shortens queues at service counters, and increases user satisfaction.

- For example, in libraries with heavy daily footfall—such as IIT Delhi or IIM Calcutta—RFID-enabled kiosks have dramatically reduced congestion during peak hours.
- Self-service also empowers students and faculty to conduct transactions independently, increasing convenience and accessibility, especially outside of peak service times.

### *b) Rapid and Accurate Inventory Management*

Inventory management is traditionally labor-intensive, with staff scanning each barcode individually. With RFID, **handheld readers can scan entire shelves in minutes**, capturing data from dozens of books simultaneously without removing them from their positions. This efficiency enables libraries to conduct stock verification more frequently, ensuring accurate catalog records.

- RFID also assists in locating **misplaced or “lost” books** quickly. Staff can set handheld readers to “find” mode, which emits signals when the target item is nearby.
- Such capabilities are particularly beneficial for large libraries, such as university central libraries, where collections often exceed several hundred thousand volumes.

### *c) Strengthened Security and Theft Reduction*

RFID gates installed at library exits act as an automated security system. When a tagged book passes through without proper checkout, the system immediately triggers an alarm.

- Unlike magnetic strip systems, RFID tags combine both **circulation and security functions**, making the process seamless.
- Studies in Indian university libraries have shown a noticeable reduction in book losses after RFID implementation. This is crucial for libraries with rare or expensive resources.

### *d) Optimal Utilization of Staff Time*

By automating repetitive circulation tasks, RFID frees librarians and support staff to focus on **value-added services** such as information literacy programs, research consultations, and digital resource management.

- Instead of spending hours on routine checkouts or manual stock verification, staff can contribute more actively to academic support, thereby raising the library’s profile within the institution.
- In resource-constrained environments (common in Indian colleges), this reallocation of staff duties is particularly valuable.

### *e) Enhanced Data Accuracy and Analytics*

Because RFID systems record every circulation and security event in real time, they generate **rich datasets** about user behavior, collection usage, and peak service times. This data can inform collection development policies, budget allocation, and service design.

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- For instance, circulation trends can identify high-demand subject areas requiring additional acquisitions.
- Real-time analytics also allow administrators to evaluate the effectiveness of RFID implementation itself (e.g., measuring reduction in transaction time).

### *f) User Convenience and Accessibility*

RFID improves the **user experience** not only through speed but also by reducing the intimidation of complex processes. Patrons no longer depend entirely on staff assistance and can borrow or return items autonomously.

- For differently able users, RFID kiosks can be designed with **touch screens, voice prompts, and ergonomic layouts**, making them more inclusive than traditional counters.

### *g) Space and Workflow Optimization*

RFID supports **automated book-drops** and sorting systems. Returned books can be placed in RFID-enabled return boxes, which automatically check them back into the ILMS. In advanced setups, conveyor-based sorting sends items directly to designated shelves or sections.

- This reduces backlog at circulation desks and accelerates book turnaround time, ensuring materials are available to other users more quickly.

### *h) Support for Hybrid and Future Services*

RFID infrastructure can integrate with **mobile apps, smart ID cards, and digital lockers**, paving the way for hybrid library services. For example, a university could link student ID cards to RFID kiosks for seamless authentication. RFID also prepares libraries for **future technologies**, such as Internet of Things (IoT)-based smart libraries.

## **3. Challenges and Problems of RFID in Academic Libraries**

Although RFID technology provides remarkable advantages, its implementation in Indian academic libraries is not without challenges. Libraries often encounter barriers related to **financial investment, technical issues, privacy, and human resource adaptation**. These challenges must be recognized and addressed for successful adoption.

### *a) High Initial Investment and Maintenance Costs*

The **most significant hurdle** for Indian libraries is the cost of RFID implementation. The system requires purchasing RFID tags, gates, self-check kiosks, handheld readers, and middleware. Tagging each book can cost between ₹15–30 per item, and large university libraries often hold collections exceeding several lakh volumes.

- For example, tagging a collection of 3 lakh books could require a budget of ₹45–90 lakhs solely for tags, excluding gates and kiosks.
- Annual maintenance contracts (AMC), software updates, and replacement of damaged tags add recurring expenses.

This cost barrier prevents smaller colleges and universities, especially in resource-constrained regions, from adopting RFID widely.

### *b) Time-Consuming Tagging and Retrofitting*

Every single item in a library must be tagged and encoded before the system becomes functional. For older libraries with legacy collections, this can be extremely **time- and labor-intensive**.

- If outsourcing is used, costs rise further; if tagging is done in-house, normal library operations may be disrupted.
- Rare and fragile materials, such as manuscripts or oversized books, pose additional difficulties in tagging.

*c) Technical and Environmental Limitations*

RFID systems are not infallible. Several **technical constraints** can reduce effectiveness:

- **Interference from metallic covers** or tightly packed books reduces tag readability.
- **Power fluctuations**, common in some Indian institutions, may disrupt RFID hardware.
- Environmental factors such as **dust, humidity, and heat** (especially in non-air-conditioned spaces) can damage equipment and reduce performance.

*d) Vendor Lock-in and Compatibility Issues*

Some vendors supply **proprietary RFID tags or middleware**, which may not comply with international standards like **ISO 15693** or **ISO 28560**. This creates risks of **vendor lock-in**, where the library becomes dependent on a single supplier for future upgrades and replacements.

- In India, several libraries have reported difficulties when shifting from one vendor to another due to incompatibility of previously tagged collections.
- Adopting **ISO-compliant tags and SIP2/NCIP protocols** is essential but not always enforced during procurement.

*e) Privacy and Security Concerns*

RFID systems can inadvertently raise **user privacy issues**. Although tags usually contain only an item's ID, they can potentially be scanned by unauthorized devices outside the library premises.

- Malicious actors could track which books a user has borrowed, leading to possible **breaches of academic freedom** or profiling.
- In addition, RFID tags are vulnerable to **cloning and tampering**. If adequate encryption or blocking measures are not implemented, security systems may be bypassed.

*f) Resistance to Change and Staff Training*

Human factors often play a bigger role than technical ones in successful adoption. Library staff may resist RFID due to:

- Fear of job loss (since automation reduces circulation desk work).
- Lack of technical knowledge or confidence in operating new systems.
- Inadequate training provided during implementation.

Similarly, some patrons may initially distrust self-check systems and continue to prefer traditional service counters.

*g) Risk of System Downtime*

If the RFID server, software, or gates fail, library operations may be severely disrupted. Unlike barcode systems (which can continue manually with scanners), RFID often requires specific infrastructure, making it more vulnerable to **complete service breakdowns**. Libraries must plan for backup procedures and IT support.

*h) Ethical and Accessibility Issues*

- Not all self-service kiosks are **inclusive** for visually impaired or physically challenged users. Unless designed with accessibility features, RFID could inadvertently exclude certain groups.
- Ethical concerns also arise around the **replacement of human interaction** in library services. For many users, librarians are not just service providers but guides and mentors. Over-reliance on RFID automation may weaken this relationship.

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### *i) Limited Awareness and Uneven Adoption in India*

While premier institutions like IITs, IIMs, and central universities have adopted RFID, many state universities and smaller colleges—particularly in semi-urban and rural India—lack awareness or financial support for such initiatives.

- This creates a **digital divide** within the academic library ecosystem of India, where only elite institutions enjoy advanced services while others continue with outdated systems.

### *j) Sustainability and Future-Proofing*

RFID technology itself is evolving. If libraries invest heavily in systems that become obsolete in a decade, this may create wasted expenditure. Ensuring **future-proof procurement** (e.g., RFID systems that can integrate with IoT or cloud platforms) remains a challenge.

## **4. Comparative Analysis: Advantages vs. Challenges of RFID in Academic Libraries**

<b>Aspect</b>	<b>Advantages</b>	<b>Challenges/Problems</b>
<b>Circulation</b>	Faster issue/return; multiple books processed at once; supports self-service kiosks	Requires expensive kiosks; downtime can halt operations
<b>Inventory Management</b>	Quick stock verification; handheld readers scan shelves without removing books; easy detection of misplaced items	Tagging legacy collections is time-consuming; damaged/misread tags reduce accuracy
<b>Security</b>	Exit gates prevent unauthorized removal; dual function of tags (circulation + security)	Tags vulnerable to tampering/cloning; requires constant maintenance
<b>Cost and Resources</b>	Reduces long-term labor costs; staff can focus on user services instead of routine circulation	High initial investment (tags, gates, kiosks); recurring maintenance and AMC expenses
<b>User Experience</b>	Empowers patrons with self-check and book-drop options; reduces queues; supports accessibility	Some users distrust self-service; kiosks may not be inclusive for all (e.g., visually impaired)
<b>Staff Role</b>	Frees staff from repetitive tasks; enables more academic/research support services	Staff resistance due to fear of job loss; need for training and re-skilling
<b>Data and Analytics</b>	Generates real-time usage data; informs collection development and service design	Risk of privacy breaches if user/book data is accessed without authorization
<b>Technology</b>	Supports hybrid systems (smart cards, IoT, mobile apps); scalable for future needs	Vendor lock-in; incompatibility with non-standard tags or systems
<b>Sustainability</b>	Improves book circulation efficiency, reduces book loss, optimizes resources	Risk of rapid technological obsolescence; difficult for smaller libraries to sustain costs
<b>Adoption in India</b>	Successfully implemented in IIT Delhi, IIM Calcutta, University of Hyderabad, Presidency University (West Bengal), etc.	Uneven adoption: mostly elite institutions; smaller/state universities lag behind

**1. Examples of RFID implementation —**

**A) India (selected)**

- **Indian Institute of Technology Delhi (IIT Delhi)** — IIT Delhi's Central Library uses RFID for self-check/return, security gates, and inventory operations; the library also publishes user help materials (video/manual) showing patron RFID self-issue workflows.
- **IITs across India (IIT Kharagpur, IIT Roorkee, IIT Chennai etc.)** — Multiple IIT campuses have implemented RFID systems in their libraries to enable faster circulation, book drops, and inventory management. (Several IIT libraries report RFID deployments in technical reports and articles on library automation.)
- **IIM Calcutta (Bidhan Chandra Roy Memorial Library)** — The library implemented an EM-RFID system; pre- and post-implementation studies have reported time savings in issue/return workflows and reduced manual handling.
- **Rajendra Prasad Central Agricultural University (RPCAU)** — RPCAU recently announced full automation of its central library using RFID, adding self-service and app features to manage a large collection. (News coverage in 2025.)
- **University libraries with published case studies** — Several Indian universities (for example UPES and University of Kashmir) have published case studies and academic articles documenting RFID pilots and deployments, describing both benefits and implementation lessons.

**B) West Bengal (selected)**

- **Jadavpur University (Kolkata)** — Recent academic studies have investigated (and documented) the status and awareness of RFID implementation in Jadavpur University's Central Library, indicating active or partial adoption and exploring user/staff awareness and operational issues.
- **IIM Calcutta (Kolkata)** — (Already listed above) — Bidhan Chandra Roy Memorial Library at IIM Calcutta implemented EM-RFID; their case study is frequently cited as a local (Kolkata) example of RFID benefits and challenges.
- **University of Calcutta & University of North Bengal** — Scholarly work from the region (University of Calcutta Dept. of Library & Information Science and comparative studies) reports that University of Calcutta and University of North Bengal are among the West Bengal institutions that have explored or implemented RFID technology in library services. These university sources and local seminar proceedings discuss both deployments and security/privacy concerns in regional university libraries.
- **Visva-Bharati / Palli Siksha Bhavana** — Visva-Bharati's library system is computerized and regional publications reference modernization initiatives; local library publications and proceedings (including seminars on RFID) show West Bengal institutions engaging with RFID and related automation topics. (See Visva-Bharati library pages and seminar proceedings.)

**6. Recommendations for Successful Implementation of RFID in Academic Libraries in India**

The successful adoption of RFID in academic libraries requires careful planning, adequate funding, and sustained institutional support. While challenges exist, they can be mitigated through strategic measures. The following recommendations are proposed:

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### *a) Ensure Adequate Funding and Government Support*

- **Government and UGC/AICTE Grants:** Many academic libraries in India cannot afford RFID independently. Central and state governments, as well as funding agencies like UGC and AICTE, should create special grants for automation and RFID adoption.
- **Consortia-Based Models:** Libraries within a university system or regional networks could collaborate to share costs of RFID procurement, training, and maintenance.

### *b) Vendor-Neutral Procurement and Standards Compliance*

- Libraries must adopt **internationally recognized standards** such as ISO 15693 and ISO 28560 to avoid vendor lock-in.
- Procurement contracts should ensure **compatibility with future systems** (e.g., SIP2/NCIP protocols for integration with ILMS).
- Open bidding processes with clear technical specifications can reduce over-dependence on a single vendor.

### *c) Comprehensive Staff Training and Change Management*

- Continuous training programs should be organized for library staff, covering technical skills, troubleshooting, and user guidance.
- Awareness sessions can address fears of job loss by highlighting the new roles librarians can play in **research support, digital literacy, and academic mentoring**.
- Peer-learning models, where early adopters (like IITs and central universities) train nearby institutions, could be highly effective.

### *d) User Orientation and Accessibility*

- Libraries should conduct **user awareness workshops** to familiarize patrons with RFID kiosks, book-drops, and security systems.
- Self-service kiosks must be **accessible to differently able users**, with features like tactile buttons, screen readers, voice prompts, and ergonomic design.
- Mobile-based integrations (e.g., RFID-linked apps) can further enhance convenience for digitally literate users.

### *e) Backup Systems and Risk Management*

- Libraries must establish **contingency procedures** for power failures, network downtime, or RFID hardware malfunction.
- Barcode scanning systems should be retained as a fallback, ensuring uninterrupted service.
- Regular audits and preventive maintenance should be scheduled to minimize disruptions.

### *f) Privacy and Security Safeguards*

- RFID systems should be configured to store only **minimal information** (unique item IDs) on tags, preventing potential misuse.
- Encryption and secure middleware must be used to safeguard against unauthorized access and cloning.
- Clear **privacy policies** should be communicated to users, ensuring trust in the system.

### *g) Gradual and Phased Implementation*

- Instead of implementing RFID across the entire collection at once, libraries can begin with **high-demand sections** (e.g., textbooks, reference materials).
- A phased approach allows for testing, troubleshooting, and gradual familiarization among staff and users.

- Lessons learned during initial phases can inform wider rollouts.
- h) Promote Research and Best Practices*
- Academic institutions should document and publish case studies of RFID implementation (successes and failures) to build a **knowledge base for other libraries**.
  - National and regional library associations (like ILA, IASLIC, and MANLIBNET) can organize conferences and workshops dedicated to RFID adoption and innovation.

## CONCLUSION

The implementation of RFID in academic libraries across India represents a significant step toward modernization and enhanced service delivery. By automating circulation, improving inventory control, strengthening security, and offering self-service options, RFID has the potential to transform library operations and meet the growing demands of 21st-century learners (Bansode & Desale, 2009; Rai & Kumar, 2011).

However, despite its advantages, the technology faces challenges such as **high installation and maintenance costs, interoperability issues, lack of staff training, and privacy concerns** (Pandey & Mahajan, 2017; Singh & Upadhyay, 2014). Moreover, the uneven pace of adoption across India highlights the **digital divide** between well-funded institutions such as IITs and central universities, and smaller state or rural colleges with limited budgets (Agarwal & Sharma, 2016).

The examples of successful implementations at **IIT Delhi, IIM Calcutta, and Jadavpur University** in West Bengal demonstrate that RFID is not only feasible but also scalable in the Indian context when institutions have proper planning, funding, and training in place (Kumar & Choudhury, 2016; Chachra & Verma, 2014). For widespread adoption, policymakers, government agencies like UGC and AICTE, and library associations (ILA, IASLIC, MANLIBNET) must actively support institutions by providing **financial assistance, training opportunities, and vendor-neutral implementation guidelines**.

In conclusion, RFID is not a mere technological upgrade but a **strategic investment in the future of academic libraries in India**. If properly adopted, it can transform libraries into **smart, user-friendly, and globally competitive knowledge centers**, empowering students, researchers, and faculty alike. The key lies in **phased implementation, collaborative approaches, and a strong policy framework**, ensuring that Indian libraries remain relevant and resilient in the digital age.

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