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RFID and It's Use in Libraries: A Literature Review

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Abstract

The paper highlights the importance of RFID system in libraries and reviews various studies emphasising on the advantages and problems in implementing RFID in libraries. The studies have been categorised into two parts– studies conducted on the use of RFID abroad and studies conducted on the use of RFID in India.

KeyTerms: RFID, Radio Frequency Identification, Use of RFID in Libraries.

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Introduction

RFID, which stands for Radio Frequency Identification, is a means of identifying a person or object using radio waves to communicate among a system of integrated circuits, tags, readers and software to identify items. RFID refers to the technology in which the RFID tag transmits a radio frequency signal that is picked up by a reader. Radio waves transmitted from an antenna interact with an integrated circuit embedded on an RF tag, which sends radio waves back to a reader. The reader turns those waves into digital information, allowing the item that respond to be instantly identified. RFID is widely used today in many areas such as logistics, supply chain management, Warehouse management and logistics, medical implants, road tolling, building access control, aviation security, luggage tracking at airports, libraries, etc.

RFID and Libraries

Libraries are also not lagging behind in the use of RFID technology. These are tagging books with RFID tags to quickly locate misplaced books on the shelves and enable self checkouts. According to Dictionary of Library and Information Science (2004), 'RFID technology is the use of microchips to tag library materials and the 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. When an RF tag (transponder) passes through the electromagnetic zone, a reader (antenna + transceiver) decodes the data encoded in the tag's integrated circuit, passing it to a computer that corresponds to the library card. Line-of sight is not required for this non-contact system. RFID technology may eventually replace the barcode and optical technology in library circulation systems. Tags are available in various shapes and sizes for use in a wide range of applications, with read/write capability for interactive applications. The fact that high-frequency radio waves can be used to track moving objects at a distance has raised concerns about privacy'. RFID system make self-checkout faster and easier for library patrons and RFID portable scanners can take inventory by just being passed slowly along the library shelves, without having to handle each item individually. Use of RFID save time and it operate more efficiently and effectively than the barcode systems. However, the cost factor is the major barrier of using such technology to the maximum. As more and more manufacturers of RFID tags, readers and software solutions are entering the market, it is expected that the price of the technology will continue to decline and practical applications will continue to grow. This will ultimately lead to more use of the technology by those who cannot use it due to scarcity of funds. The following literature reviews the studies carried out on the theoretical base of RFID, it's components and use in libraries and information centers. The results in SCOPUS Citation database as well as WEB of SCIENCE reveal that there is no literature available on application of RFID in libraries prior to 2000. Whatever literature is available, it deals with application of RFID in other sectors including mining, aviation, logistics, etc. The literature related to RFID use in libraries is given below.

Studies on use of RFID in libraries carried abroad

Chia in his paper entitled 'Transformation of libraries in Singapore' reported that the National Library Board has strongly felt that there is a need to transform the present library system of Singapore influencing four building blocks, i.e., content, services, people and infrastructure. He opined that the transformation of libraries in Singapore could only be possible with proper implementation of the recommendations given by NLB. He claimed that the NLB was the first in the world to launch an Electronic Library Management System (ELiMS) which takes less than 15 minutes queuing to borrow material during peak periods and zero minute queuing time for book returns. He stated that with ELiMS, stocktaking of books in a library which used to take two weeks earlier, now takes less than a day. He highlighted that the NLB and its technology partners were jointly awarded the International Certificate of Grant of Patent in December 2000 for RFID application in libraries[1].

Yorkovich in his article entitled 'Lied Library: at the forefront of technology with 3M digital ID collection management' stated that the use of 3M Digital ID streamlined flow of library material and saved the time of library staff on performing routine tasks such as finding lost items, weeding the collection, properly shelving items and performing shelf reading in a fraction of time. He opined that with 3M Self Check System, users can check out the material themselves without the assistance from the library staff. He concluded that DLA is among the most revolutionary technology to affect the way libraries manage information and with the use of this technology, a library becomes a more efficient place to retrieve information[2].

Fabbi et al. in their article entitled 'Implementation of 3M digital identification at UNLV Libraries' outlined the challenges and discoveries in the development of the RFID system and its implementation differences between a small and a large library. They forecasted the future growth for both product development and UNLV libraries use of the system and stated that after the implementation of 3M Digital Identification System at UNLV libraries, performance and efficiency of the library staff has increased and users can independently check out library materials and can find out the books properly arranged on the shelves due to the capabilities of the Digital Library Assistant[3].

Ngian in his paper entitled 'A Totally Do-It-Yourself Library without a library customer service desk : The Singapore experience' reported that with the implementation of RFID, the library has automated its circulation function including the payment of overdue fines and other payments via a national cash card, checking of loan records online and in real-time and registration of new members[4].

Kern and Nauer in their article entitled 'Implementing RFID in libraries for process automation experiences from over twenty current installations' surveyed RFID installations in over 20 libraries in Switzerland and observed that it is possible to guide more than 90% library visitors towards the RFID stations. The public library in Vienna reported about 60% visitors use self-checkout stations. They reported that for the introduction of the RFID technology in libraries, two main factors are relevant which include the development of prices and the availability of standards. They claimed that prices came down more than 50% from 2003 to 2004 due to the increased application in other industry sectors (logistics, personnel identification). Accordingly, the investment costs for RFID became lower and seem to be affordable in more libraries[5].

Molnar and Wagner in their article entitled 'Privacy and security in library RFID issues, practices, and architectures' suggested that privacy risks are negligible unless an adversary has access to library databases. They identified private authentication as a key technical issue, i.e., how can a reader and tag that share a secret efficiently authenticate each other without revealing their identities to an adversary. They proposed a general scheme for building private authentication with work logarithmic in the number of tags, gave a scheme with linear work as a sub-protocol. They also suggested a simple scheme that provides security against a passive eavesdropper using XOR alone, without pseudo-random functions or other heavy crypto operations. They concluded that once the American Library Association proposes the best practices for the library use of RFID, the adoption rate of RFID technology in the libraries will rise[6].

Hopkinson and Chandrakar in their study entitled 'Introducing RFID at Middlesex University Learning Resource' observed that self check out and self-return quickly became very popular amongst the users and usage quickly reached to 64 per cent of issues and returns. With the use of RFID technology, the amount of staff time engaged in circulation and stock management has also reduced. They concluded that with the implementation of RFID, library services became more user-friendly[7].

Palmer in his article entitled 'Using RFID to Transform Essex Libraries' found that RFID offered not just a solution to the security question, but also the possibility of self service and stock management facilities not available from traditional solutions. He revealed that RFID self service has became popular with library customers and has enabled significant changes in delivery of library service and its ease of use enabled self-service to account for around 50 percent of total transactions[8].

Selamat and Majlis in their study entitled 'Challenges in Implementing RFID Tag in a Conventional Library' opined that while implementing RFID technology in IMEN University of Malaysia, main challenges during the implementation related to system integration, parallel operation with existing system, and procedure changes. They highlighted that one of the main challenge was to integrate RFID tagging system with the Library Management System. They opined that self-check counter makes borrowing and returning book process more automated with less involvement of librarians; therefore librarians can focus on providing more effective work to better serve the library. They suggested that it is necessary to have both systems, i.e, barcode and RFID running in parallel so that library could operate normally while conversion process is in progress[9].

Shamsudin in their paper entitled 'RFID-based intelligent books shelving system' stated that searching and sorting misplaced books is a difficult task often carried out by the library personnel and it is almost impractical to place all books back at their assigned locations daily[10]. RFID based intelligent shelving system provides an efficient mechanism of books management monitoring through wireless communication between the RFID reader and the book. They discussed about the performance of RFID reader and tags data management such as retrieving information, matching with database, sorting out the order and

displaying the status about the books. They concluded that the performance of the RFID based intelligent shelving system has been investigated and found to be satisfactory and it has a lot of potential, especially in its ability to alleviate the intensive labor and efforts in shelving books[10].

So and Liu in their article entitled 'Learning from failure: a case study of adopting radio frequency identification technology in library services' stated that RFID aims at enhancing customer experience and improving operation efficiency in many business sectors. They pointed out issues in its implementation and developed strategies to tackle the problems. They analysed the organisation's willingness for adopting RFID technology in a medium-sized library. They opined that successful implementation of a technology for an organisation depends on many factors, out of which organisation's readiness is the most important. The readiness of strategy, people, process and system maturity should be assured for implementing the technology successfully[11].

Muir in his paper entitled 'RFID security concerns' noted that increasing number of libraries are implementing RFID solutions while supplementing or replacing their existing barcode systems. He pointed out that while RFID offer many benefits including productivity enhancement, it also exposed libraries and their patrons to a number of potential violations of patron privacy both inside and outside the library. He opined that in an era when there is an escalating ongoing debate over libraries and patron privacy, RFID warrants further review. He explored the validity of some of these concerns and outlined recommendations and best practices to minimize the risks to libraries and their patrons. He suggested that the potential risks associated with RFID security violations are a potential threat and any library implementing the RFID system should be aware of it[12].

Butters in his paper entitled RFID in Australian academic Libraries: exploring the barriers to implementation outlined the benefits of RFID in libraries and suggested a range of factors that might contribute to the lack of the technology's penetration into the Australian academic library sector. He pointed out that since 2002, RFID system has been installed in a growing number of Australian libraries including public, school and special libraries and reported three positive outcomes of implementing RFID which include productivity, occupational health and safety and collection management[13].

Yu in his article entitled 'Implementation of an innovative RFID application in libraries' described the Shih-Hsin University Library UHF RFID system which uses long distance induction to assist in three innovative applications. He stated that RFID can replace barcodes and magnetic strips for security control and collection management and library can provide innovative library services, i.e., seeking and positioning, access and reading rate measure, location information for library collections, etc. He concluded that although implementation of RFID improves service efficiency for libraries, yet regulating necessary standards, processes, and interfaces and extend automatic library operations require continuous efforts[14].

Golding and Tennant in their article entitled 'Evaluation of a Radio Frequency Identification (RFID) library system: Preliminary results' observed that the books closest to the metal separator or to the metal upright were consistently misread. These books had to be physically removed from the shelves to obtain a reading. They reported that there was no observable effect with the performance of self-check station and RFID transmission and also the reception with the inclusion of cell phone, laptop and computers[15].

Ching and Tai in their paper entitled 'HF RFID versus UHF RFID-Technology for Library Service Transformation at City University of Hong Kong' observed that since the start of the UHF RFID pilot test in April 2008, check-outs of the Semi-Closed collection has increased by 50%.They found that performance of UHF RFID tags in the security gates was superior to HF and concluded that UHF RFID outperformed HF RFID in terms of tag reading rate, multiple-item detection rate, orientation of tag detection and read range for self-check machines and detection gates[16].

Caldwell-Stone in his paper entitled 'RFID in Libraries' reviewed the privacy recommendations made by NISO's RFID Working Group for its use in U.S. libraries. He suggested that best practices for RFID in the library should not only facilitate use of the technology but also promote the library's distinctive mission and preserve users' privacy rights. He pointed out that Standards and recommended practices can be revised and re-written to accommodate new RFID applications. He concluded that such standards should make privacy protection a primary goal and not a secondary goal, when implementing RFID.

Cunningham in his study entitled 'A case study into the implementation of RFID at the Pilkington Library Loughborough University' reported that the library users gave positive feedback on the new system and 91% successfully used the new system in the first year. The average usage of 93% in the second year was 13% higher than the original target. The required efficiency saving was met with staff reductions within the first 12 months of implementation[17].

Feng in his paper entitled 'Research for Application of RFID in Library' highlighted the advantages of RFID technology as scanning quickly, non-contact reading and writing, long service life, high information content, etc. He stated that the RFID technology can manage the location of the library books, distribution and circulation, enhance the book classification, standard codes, location and data collection, thereby greatly improving the efficiency of the library. He highlighted the problems in the implementation of RFID include no unified standards, high cost, security and integration with the library management system, etc. However, he believed that in the near future, RFID technology in Chinese libraries will achieve good results[18].

Mehrjerdi in her paper entitled 'RFID: the big player in the libraries of the future' highlighted the key risk factors related to the library of the future having RFID-based system which includes initial cost, IT infrastructure cost, skilled RFID workers, data security, patron issues, etc. She also highlighted some of the key benefits of RFID in libraries like information management, efficient circulation operation, better inventory control, data accuracy and reliability, theft prevention, etc. She stated that RFID-based system can be integrated into existing library system to improve the efficiency of the main processes carried out in any library such as stocktaking and book searches and increase the quality of services to be provided[19].

Repanovici and Cristea in their article entitled RFID technology used in small library - case study at Transilvania University

proposed Koha (open source library management system) with RFID technology in order to achieve an economical solution with large applicability. They discussed the problems regarding the implementation of RFID technology in library: privacy issues; inter-library operations due to differences in tags or software; readers and sensors influenced by metal shelves; more expensive than barcodes and security strips[20].

Zimerman in his paper entitled 'Radio frequency identification (RFID): time to take another look' found that prices of RFID chips and equipment has dropped significantly. He opined that RFID once set up, could place the burden of cataloguing, circulation and collection management on the computer rather than on staff. He strongly recommended that if a library cannot afford it now in its entirety, it should consider adopting and implementing it in carefully staged phases. He concluded that RFID costs are coming down, efficiency is going up and libraries can improve their systems enormously.

Thornley et al. in their paper entitled 'Do RFIDs (radio frequency identifier devices) provide new ethical dilemmas for librarians and information professionals?' stated that RFID raise two main privacy concerns in the library environment both of which relate to the increased risk of surveillance, through the greater capacity to track items and through the potential for hot-listing. They opined that it is not possible to connect information from an information object to a user by exploiting the RFID, unless one also has an access to the Library Management System. They concluded that RFID technology provides new additional tool for data collection and if the privacy of library user is broken, it will certainly raise new ethical questions for the library and information professions[21].

Sun & Chen in their paper entitled 'A proposed model for library stacks management' developed a new stacks management model called 'parent-child-grandchild model' by changing the layout of the book stacks, the management principles as well as by employing the RFID. In such a model, Book stacks are divided into three sections, one large ('parent'), one medium 'child' and one small 'grandchild'. The three sections comprised the entire printed collection of a library, representing different functions and use of the stacks. They pointed out that a library needs a good RFID support facility which helps the library staff to manage printed material more effectively and library users to find the physical location of books. They discussed the transaction processes, production processes, governance processes, interaction process and facilitation process of RFID. They concluded that it is a revolutionary idea to implement the new model, which attempts to achieve not only better stack management but also a more friendly and attractive library image[22].

Sandu & Ukwoma in their article 'Awaking stock taking practice in academic libraries, The Radio Frequency Identification (RFID) technology' opined that with the implementation of RFID technology, stock verification can be done within a few hours with the help of DLA. The DLA allow libraries to keep track of missing books, books on loan, etc. It also helps in proper arrangement of books in the stack area. They reported that the use of RFID yields excellent results, enhance search and identification processes in the library, helps in streamlining various major library operations like stocktaking and book search. They concluded that though the RFID technology is expensive, it is believed that with time and use in libraries, it's cost may come down[23].

Makori in her paper entitled 'Adoption of Radio Frequency Identification technology in university libraries: A Kenyan perspective' found various problems hindering the adoption of the technology in the universities in Kenya which include lack of information communication technology policies, lack of a business approach, limited market opportunities, lack of lobbying or negotiating skills, inadequate funding and budgeting and lack of ICT competencies and skills. She recommended that library ICT professionals, information professionals and other stakeholders should make tireless efforts to implement and use RFID technology with the view to building, strengthening, improving and supporting information work and activities in university libraries[24].

Sugie in his article entitled 'application of Radio Frequency Identification technology to study library users' information-seeking behavior' analysed two approches of RFID technology to assess information-seeking behaviour in the university library in Saitama, Japan. He opined that RFID was found to be an effective tool for revealing and analyzing pattern of information-seeking behaviour of library users and can also be applied to the assessment of whether services or locations of resources in a given library are adequate. He highlighted that the greatest advantage of RFID was that more data was collected with greater ease and accuracy than with traditional methods. The noted disadvantages of the RFID were that locating tags required much effort and that the RFID system could not guarantee enough accuracy of the read range[25].

Dwivedi et al. in their article entitled 'RFID systems in libraries: An empirical examination of factors affecting system use and user satisfaction' stated that library operation and management require the performance of a number of repetitive, painstaking, labour and time-intensive activities. Hence, in order to increase efficiency and effectiveness, many libraries are moving towards automation of majority of their activities and are deploying RFID technology as a substitute for barcode systems. They highlighted some issues which include cost, difficulty in reading ultra-high-frequency tags near a human body, multiple item readings, etc. related to the implementation of RFID technology. They emphasised that RFID-related issues largely concentrate on technical, organizational and implementation aspects, and less attention has been paid to understanding its use and user-satisfaction aspects. They developed a conceptual model to examine factors affecting the use of RFID-based systems and user satisfaction. They found that factors like system quality, information quality, service quality, etc. have a significant positive influence on system use and users' satisfaction. They indicated that users prefer using the RFID terminals (shelf-check out/check-in) for the issue / return of books from the library[26].

Studies on Use of RFID Carried Out in India

NagaLakshmi et al. in their paper entitled 'A security mechanism for library management system using low cost RFID tags' opined that RFID system has been in use in libraries for book identification, self checkout, anti-theft control, inventory control and for sorting and conveying of library books and audio visual material. These applications can lead to significant savings in

labor costs, enhance customer service, lower book theft and provide a constant record update of media collections. They concluded that the new generation of RFID chips with the ISO standard 15693 are now available and with this technology, libraries are not dependent on any one company for their lifeline27.

Kumar et al. in their paper entitled 'Development of RFID Interface for LMS: Solutions and Techniques' examined various issues related to integration of Library Management Software and RFID. They observed that the SIP2 interface developed for integrating RFID with SOUL is a general solution, which can be adopted for any LMS software with slight modifications. They opined that introduction of such a solution in the academic libraries in the country will boost the modernization activities to turn the library to a fully user-centered automated library28.

Ghosh in his paper entitled 'Application of RFID Technology in Sardar Vallabhbhai National Institute of Technology (SVNIT), Surat' described that RFID is the latest technology to be used in different industries for security and theft detection. He observed that although the system is costly and has some demerits, yet it is accurate, cost effective and require less manpower. He recommended that if budget does not permit a library to introduce complete system at a time, it may be divided in two or three phases29.

Pattnaik & Pattnaik in their article entitled 'RFID: The Security for Library' highlighted about the genesis, overview and technology associated with the implementation of RFID technologies in library application. They discussed major standards and components of RFID system. They opined that though few libraries are employing this technology today, but due to its customizable features and continuing improvement, the library communities are beginning to get involved in its development. They highlighted some barriers of RFID use like technological barrier, cultural barrier, financial barrier, lack of proper standards, blocking the RF wave, etc. and stated that these are the major concerns that need to be addressed before implementing this technology30.

Singh & Midha in their article entitled 'RFID: A new technology in library management systems' discussed the importance of using RFID in libraries and highlighted its various advantages like speedy circulation operations, self-charging/discharging, highly reliable, high-speed inventory control, automated handling of material, long life of RFID tags, etc. They also discussed the disadvantages of RFID systems like high cost, accessibility to compromise and removal of exposed tags. They pointed out some of the characteristics to be considered while evaluating RFID vendors which include security feature, reader collision, tag memory capacity, anticollision, standards, etc. They concluded that RFID is increasing in popularity among libraries, as the early adopters of this technology have shown that it makes good economic sense for all types of libraries31.

Bansode and Desale in their case study entitled 'Implementation of RFID technology in University of Pune Library' highligted various problems faced by library staff with regard to the lack of availability of technology experts, resistance of the users towards change, lack of standards, etc. They reported major benefits of implementing RFID in stock verification, tracking of shelving of the books and missing books, quick circulation of books, inventory control, etc. They concluded that RFID technology is a boon for a library, as it requires less manpower to service more books and users[32].

Vasishta in her paper entitled 'Roadmap for RFID Implementation in Central library, PEC University of Technology' described the basic and optional components required for smooth working of the RFID. She outlined various issues and possible solutions involved in the process of implementing RFID applications. She concluded that although the RFID technology is quite expensive, yet it has yielded excellent results for many libraries throughout the world. It has the capability of making the management process in a library more convenient and the synergy between the latest technology like RFID and libraries can create wonders resulting in empowerment of both users as well as the librarians[33].

Blansit in his paper entitled 'RFID terminology and technology preparing to evaluate RFID for your library' opined that it is possible for libraries to use RFID without adding appreciably to privacy concerns. He stated that there is as such no privacy issue with the use of RFID system in libraries because without access to the library's automation system, a user cannot make any determination of the item from the RFID tag. He hoped that an understanding of the underlying principles of RFID as well as an explanation of RFID system commonly used in libraries will aid the librarian in investigating the possible use of RFID within a library.

Mahajan in their paper entitled 'Application of RFID Technology in Libraries and Role of Librarian' highlighted the advantages of RFID in libraries which include self charging/discharging, reliability, streamlined inventory management, longitivity of tag life, faster circulation, high level of security, etc. They emphasised that librarians have to take an extra step to ensure the privacy of their patrons. They concluded that RFID technology is more effective, convenient and cost efficient in library security and has slowly begun to replace the traditional bar-code and electromagnetic security strips[37].

Margam in his paper entitled 'RFID technology implementation in two libraries in New Delhi' examined the use and implementation of RFID technology in the libraries of Indian Law Institute (New Delhi) and National Social Science Documentation Centre, (New Delh). He found that after the implementation of RFID in both the libraries, the check-in and check-out time was reduced to less than 20 seconds per item and the use of the libraries has also increased. High cost was the most significant challenge faced after implementation of RFID technology. He highlighted the advantages of RFID technology for libraries and recommended the use of RFID technology in other libraries for faster and better services to their users. He suggested that as the RFID technology is very costly and cannot be changed frequently, thus good quality tags should be used so that there is no need to remove exposed tags frequently. He also suggested that anti-virus protection should be made with the self-service of RFID. He concluded that the future of libraries lie in RFID technology and it is expected that in the coming years, the cost will come down further and soon more libraries in India will adopt this technology[34].

Radha in her paper entitled 'Deployment of RFID (Radio Frequency Identification) at Indian academic libraries: issues and best practice' stated that the RFID technology is applicable to

various activities in libraries like automated check in/check out (without the intervention of the library staff), theft detection, stock verification, etc. and comprise many components including RFID tags/labels, library staff station, security gate, self service units, shelf management, etc. and it can be extended to many more areas in future. She concluded that as RFID has its own issues and benefits, most of the Indian institutions have started implementing RFID for tracking the library materials, for detecting theft and auto check in /out, etc[35].

Conclusion

The above review of literature indicates that most of the studies have mainly been carried out on the theoretical aspect of RFID in academic libraries including the advantages/disadvantages and problems related to RFID application. However, not many empirical studies have been carried out about the actual usage of RFID technology in libraries either in India or abroad. Hence, comprehensive studies need to be conducted on the status, actual use and the perception of users as well as librarians in India about the RFID technology in libraries and information centres.

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