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EFFECTIVENESS OF RFID BASED LIBRARY SYSTEM: SURVEY ANALYSIS

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ABSTRACT—
Libraries are one of the significant knowledge repositories apart from e-resources used by people to gain knowledge from different areas. Significant assets of libraries are always books used to obtain data, information, source, and other relevant things necessary for real-world applications. Normally in libraries, books are distributed to the person and collect that book according to the date. Thus, it is required to allocate a well manageable and knowledgeable person in the current field who must manage all kinds of library services without any confusion and error on time. The best solution for overcoming all problems is the Internet of Things (IoT), which gives very accurate and efficient solutions on time with a significantly smaller number of errors. The RFID reader is a device used to gather information from a tag. RFID based library management system is a much better system than a barcode and other traditional library systems. It overcomes almost all problems currently facing in library management. The above conclusion has been drawn by referring and comparing many RFID library systems and the characteristics; and finally, a hybrid RFID library system was proposed in accordance with the number of needy functionalities.

I. INTRODUCTION

Libraries are knowledge repositories used by people to gain knowledge from different areas. Significant assets of Libraries are always books, which are used to obtain data, information, source, and other relevant things necessary to real-world applications. So it is vital to maintaining a Library by using some system for maintaining its better performance without any error or glitches.

Normally in libraries, books are distributed to the person and collect that book according to the date. If they return the book more than the specific date, some additional payments have been collected from that particular person. The most crucial library activities are check-in or check-out of a resource, circulation

transaction of a resource, resource maintenance actions, and so on. Thus, it is required to allocate a well manageable and knowledgeable person in the current field who must manage a kind of library service without any confusion and error on time. However, the blatant truth is, to make such an effort is tough and very challenging.

The best solution for overcoming all problems is the Internet of Things (IoT), which gives very accurate and efficient solutions on time with a significantly fewer number of errors. The RFID technology of IoT makes it very easy and straightforward with higher user satisfaction[1].

Earlier Library systems were maintained by the Barcode system, which stores the unique id of a particular resource. The reader of the barcode identifies all the resource-relevant information when the usage period of a particular barcode.

This paper aims to how RFID differs from barcode technology and List out the advanced features of RFID in the Library system than the Barcode system and find out the mechanism of the RFID library management system and find the best system among them.

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A.RFID Tag

An RFID tag is an electronic tag that exchanges information with an RFID reader through radio waves. Almost every RFID Tags have two parts, namely, Antenna and Integrated Circuit (IC). The antenna is used for receives radiofrequency waves, and IC is used for processing and store data.[2].

B.RFID Reader

The RFID reader is a device used to gather information from the RFID tag, which is used to track the individual. Here transferring data from tag to reader, RFID uses radio waves.[3].

C. The working mechanism of the library system

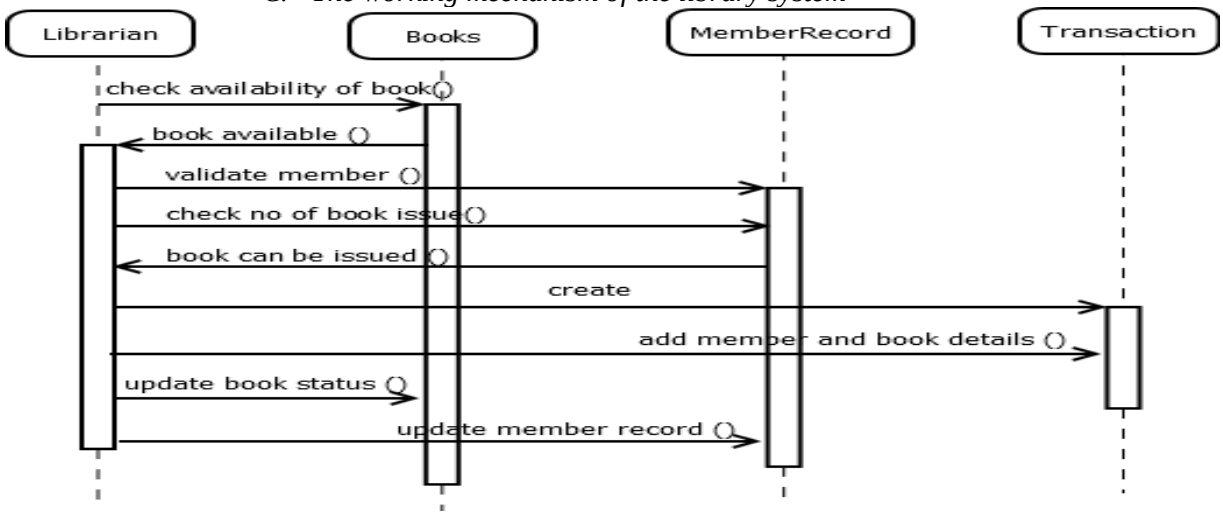

Figure 1: Sequence Diagram for a traditional working system of a Library

II. LITERATURE REVIEW

Dr. Nav Jyoti Dhingra found from his study that the advantages of RFID in the library management system indicated by users are time-saving, security, simple design, speed, and time limitless. The disadvantage is difficult to use (2.7 %), Issuing of wrong books (13.33%), Troublesome (10.83%), Hang-ups on a workstation (23.54%), and also 41.87% are said there are no disadvantages held by RFID library system. From both, we get to know that RFID gives more advantages than a disadvantage and significantly less amount of disadvantages indicated by users. So it is well fit and better technology than the Barcode system[3]. Furthermore, the satisfaction level of RFID library systems is 63.54% fully satisfied, 34.38% somehow satisfied, and only 2.08% got unsatisfied; thus, this system was accepted by users of the particular library, and RFID technology identified as a better system than a barcode. Moreover, his analysis indicates the preferred method of returning and issuing books; RFID only gets 75% and 58.75% percentage for Issuing and returning, respectively.

RFID gives a component that decreases time by perusing more than one book in the stack simultaneously. This is a better favorable position when contrasted Barcode system, and in the event of stack and flow, there is no need to hold up like a barcode system. This gives a fast perusing office in the library the board system instead of the barcode [4].

Koneru stated that RFID delivers a better library stock management system and some technical benefits; meanwhile, RFID technology provides some technical challenges too[5]. Koneru noticeably understands that RFID technology better than the barcode system in the library management system; nevertheless, the only user of that system needed to learn the new technology for well performance and adaption of that system.

Kern & Coyle said that during the barcode system, labor costs and book theft were higher, but after RFID, that range was reduced considerably [6]. This indicates the security features of RFID than the barcode system.

According to Ayre, we got to know that before RFID, library systems are too much time consuming, need laborers for security and library management, and also paper documentation work higher. However, after the invention of RFID in library management, it reduces circulation transactions, reduces staff insensitivity and eventually, it gives higher user satisfaction than a barcode and paper-based system[7].

Curran and Porter informed that RFID with the library system would be working at a higher speed than the current system[8]. This is one of the great benefits of RFID in library systems, and also, most users of any system desire to be less consumption of time. In that respect, this RFID preferably satisfies the library user by working speedily.

Hadro described from a study that RFID needs much more costly to implement; therefore, it is better to identify the advantages and cost amount that we have invested. However, this cost comes at an okay level in the continuous phase[9]. Hadro indicates that the RFID cost fits sharply in a well-defined massive library system; however, it does not appropriate for a small system, and it offers more charges even when it has more benefits.

Bansode and Desale described that RFID higher speed than the barcode system in library management and this RFID does, charging and discharging activity effortless manner and tracking the book as fast as possible[10].

Northfolk Massachusetts library surveyed to find out missing inventory documents. To do that, their estimated calculation for closing the library system is half of a week, but they had installed an RFID self-check kiosk. From that, they were done their searching without closing the library itself[11]. If they had used a barcode and paper-based system, it is impossible to finish without closing the library, and RFID provides high-speed search functionality.

Dwivedi et al. said that RFID replaced the barcode system and that done more than that in the library management system. Moreover, they said that it provides system quality, quality of information, user satisfaction, and RFID fastest, most accessible, and more efficient way to manage library material at a very cheap cost than a barcode and paper-based system[12].

Bahri and Ibrahim mentioned that inadequate knowledge is a challenge in using the RFID library management system. Moreover, RFID had many privacy issues, security, and change in a library setting and setting tagging stations. These kinds of issues are a considerable challenge for librarians to implement this kind of RFID system, even when it has various advantages[13].

Hilal Ahmad found from his study that the RFID component implemented with the library system fully supported for Self-check-in/out, Scanners, Book dropbox, RFID gates, Stock tracking or verifications, and Tagging station. This is something massive advantages of RFID in the library management system, which singly controls the entire system. Furthermore, his study identified that self-check-in/out features got accurate and worked correctly with minimal error after RFID replacement. Furthermore, in his conclusion, he identified a drawback that the length of the RFID gate, which means a tall user can hold the book above than the RFID gate, then the reader cannot read the book; thus, it could be stolen by that particular person[14]. So it is better to place an RFID reader most of the place in the library to provide tight security.

Dr.Projes Roy and Dr. Shailendra Kumar, from their discussion, recognized that 76% of users are well aware of the RFID technology in the library system and 24% are not because of the inadequate technology knowledge among library users. Moreover, in this study, they have found that RFID provides high-speed book circulation, book finding and some other things like stock verification done quick manner than a barcode. The book drop box facility was observed to be outstanding acknowledged among the user group; because of its 24 x 7 availability, the hosteller could return their books in the evening. In their system, they have additionally created an SMS alert system with RFID, which this alert system sends a message to a specific user to remind the return things of particular books and other relevant information; thus, a user can contact the library and handle the return of books without having any delays and can prevent the unnecessary cost. Eventually, they have identified the satisfaction level of all users. In this case, 81.89% were satisfied with the RFID library

system and 6% were not satisfied, and 5% are not said anything. So from their analysis, we can recognize that the RFID library system reached most library users with satisfaction and a comfortable way than other systems[15].

We acknowledged that students had been motivated by the RFID library system from a study because the system is saving time and providing convenience while using the system. Moreover, students can get and return books even after working hours due to the RFID based system. Also, this system reduces book theft in many manners rather than a barcode system[16].

Another study notifies that key benefits of RFID are fast circulation operation, self-check-in, and self-check-out in multiple documents in a rapid manner as concurrent access, privacy issues less than a barcode, high reliability and online reservation of books. Moreover, disadvantages are security gate collisions, RFID reader collision, RFID is not user-friendly due to not adaption of new technology[17].

Faizul Nisha has found RFID based library management system for five building defense science libraries. This system's benefits after devolved system are the quick issue, reissue and returning the library resources via self-help desk of a user without anyone help, search and find the massive number of books simultaneously, locate the place of particular book location, exploring the existence of the book in the particular library, accounting and inventory authentications of source and materials, anti-theft detection system and authentication while using RFID tag which increases the efficiency and identification of each user. Also, she said that from her conclusion that RFID is considered as capable, helpful, user friendly, and convenient material for the library management system and its very advanced technology than barcode system. Moreover, she said that this kind of RFID automation system is highly expensive. Thus, it is well suitable for the extensive library system and from the cost view, it is not appropriate for small libraries. Eventually, she said that even when it does not support according to economic background, in the future, when the need to increases the RFID, it becomes a reasonable cost[18].

Priti Pawar et al. described a system called "RFID based library management system" (System A). In this system, the RFID tag is given to the student to store all information inside the database. There is a PIC microcontroller pretends as an intermediate device amid RFID reader, computer and LCD. To connect PIC and computer, a serial connector has been used and the GSM module has connected to the computer. Whenever student enters the library, he/she need to swap the RFID tag and RFID Reader reads all detail stored in a database by a particular student's tag displayed on LCD and computer by PIC microcontroller. Also there are RFID tags attached with books as well. If any students want to get any book, a particular student needs to swipe that book, and it will be read by the reader and assigned to the specific student. GSM module is used to alert the students for returning the book on time. This is an automatic check-in and check-out procedure without anyone's help. There is no aid necessary for any students to getting and returning the book. RFID has quickly done everything without error. Additionally, GUI application software maintains for Admin login, finds out the users' activities, and so on. [19]

Haiming CHENG et al. designed and implemented a system called "books search and management system using RFID Technology" (System B). In this system, they have used an RFID reader in each bookshelf and each book has its RFID tag. There is software that has been created for mobile devices and users of the library can use that software. Furthermore, there is a server that has been maintained by this library, which can access by mobile devices by using WIFI. An Arduino microcontroller provides WIFI connection with RFID-WIFI shield has been used in between server and the devices.

Moreover, there is a connection between the server and a bookshelf RFID reader. It is also using the same WIFI protocol. Whenever a user enters the library, he/she needs to use their tag for user authentication. After that, if they need any books, they can search using the particular software by using book name, author and etc.. details of the same book. If the book available, the software shows the location of the bookshelf by server request-response method using WIFI. The user can go to a particular location; if they need that book, they can use the RFID reader place in the bookshelf. They do not want to go to a specific place for dealing with check-in, check-out activities. This system is a fully automatic system with RFID. There is no need for users to search every bookshelf to find a needed book, The software with server WIFI, RFID reader connection eliminate this and save unnecessary time to waste on it and check-in, check-out, book circulation and also using this kind of software, technology is effortless nowadays. A user always prefers less time consumption with a simple system; therefore, this system will increase the user satisfaction level [20].

Dong-Ying Li et al. developed a Library management system with RFID called "Internet of Things System for Library Materials Management Using UHF RFID" (System C). This system has divided into three layers, namely, the Sensing layer, the Network layer, and the Application layer. In the sensing layer, they had used Barcode and RFID tags. The purpose of the barcode is found out the ISBN (International Standard Book Number) for adding more books in the library management system. Here the android camera is used for reading the barcode system as well as RFID tags. In this library, RFID tags are embedding in all library materials, so using an Android phone, they had scanned everything instead of using an RFID reader. Also, the software has been maintaining in android to identify the books; when android senses the tag, then searching, borrowing, returning, Inventorying and finding out misplaced items of library materials can be done efficiently. The network layer acts as an intermediate in between the Sensing and Application layers. The network layer has used WLAN and 2G/3G/4G technology for speed purposes and application layer (Android Application) connect with database for finding all search, Add item, Inventory checking, Borrow/Return, Find misplaced material, and refresh items[21].

III. Discussion and Comparision

The following table shows the different functionalities of the RFID library system in accordance with the authors of the systems.

TABLE I. RFID LIBRARY SYSTEM FUNCTIONALITY WITH THE CORRESPONDING AUTHOR

Author (s)	Functionality of RFID Library System													
	self-Check in / check out	Speed	Security	Simple design	Cost	User Satisfaction	Quality	Charging /dischargin	Technological Challenges	SMS alert	Stock management	Book drop box	24 x 7 availability	Tracing books
Dr. Nav Jyoti Dhingra	N	Y	Y	Y	N	Y	N	N	N	N	N	N	N	N
Koneru	N	N	N	N	N	N	N	N	Y	N	Y	N	N	N
Kern & Coyle	N	N	Y	N	Y	N	N	N	N	N	N	N	N	N
Ayre	N	Y	Y	N	Y	Y	N	N	N	N	N	N	N	Y
Curran and Porter	N	Y	N	N	N	Y	N	N	N	N	N	N	N	N
Hadro	N	N	N	N	Y	N	N	N	N	N	N	N	N	N
Bansode and Desale	N	Y	N	N	N	N	N	Y	N	N	N	N	N	Y
Dwivedi, *et. al*.	N	Y	N	Y	Y	Y	Y	N	N	N	N	N	N	N
Bahri and Ibrahim	N	N	N	N	N	N	N	N	Y	N	N	N	N	N
Hilal Ahmad	1	N	Y	N	N	N	N	N	N	N	N	Y	N	Y
Dr.Projes Roy and Dr. Shailendra Kumar	N	Y	Y	N	N	Y	N	N	N	Y	N	Y	Y	Y
S. Khanna	N	Y	Y	N	N	Y	N	N	N	N	N	N	Y	N
Faizul Nisha	Y	Y	Y	Y	Y	N	Y	N	N	N	N	N	N	Y

Y – Indicates the conveyed functionality of RFID library system by corresponding author (s)
N – Indicates not conveyed functionality of RFID library system by corresponding author (s)

TABLE II. COMPARISON OF BARCODE AND RFID WITH THE REFERENCE OF TABLE

Characteristics	**RFID Library System**	**Barcode Library system**
Check in and check out	High	Low
Circulation transaction of source	High	Low
Speed	High	Low
Security	High	Low
Privacy problems	Low	Low
Cost	High	Low
User satisfaction	High	Low
Time saving	High	Low
Searching Source	High	Low
Quality	High	Average
Efficiency	High	Low
Error	Low	High

In this discussion part, we will discuss the advanced characteristics of RFID systems over the barcode and discuss the pros and cons of RFID over the barcode and find out the better library management RFID system for current libraries from the above three systems.

Table 1 & table 2 could identify that RFID is one of the highly advanced and flexible systems in Library management systems. Only one issue is cost. That is also could be minimized in large complex Libraries, unless small library system. It gives each single feature of library necessary things with automation with high advancement; thus, RFID is one of the best systems in Library management. Moreover, an excellent RFID library management system must consist of the functionalities of Table 1 otherwise, there no use for spending that much money and building that kind of system.

TABLE III. COMPARISON OF RFID LIBRARY SYSTEM WITH FUNCTIONALITIES

System	Functionality of RFID Library System											
	self-Check in / check out	Speed	Security	Simple design	Cost	Charging /dischargin	Technologi cal Challenges	SMS alert	Stock managemen t	Book drop box	Location pilotage services	Tracing books
System A	Y	H	H	N	H	Y	H	Y	N	Y	N	N
System B	Y	VH	H	N	VH	Y	L	N	Y	N	Y	Y
System C	Y	H	H	Y	A	Y	L	N	N	N	N	Y

Y: Yes; **N**: No; **H**: High; **VH**: Very High; **L**: Low; **A**: Average

An automated well-preferred RFID library management system must contain or meets all the functionalities in Table 3. In other word a well-designed RFID library system must have a self-check-in and check-out services, it must be work high speed than a traditional system, The security features are very high with very simple design, cost must justify from the functionality of the system, automatic charging-discharging services without inconvenience of a user, Technical challenges must be significantly less when the user consuming the system, It should provide SMS notification to the library user about the deadline issue date of the material in nearby of the date, It must have attractive stock management system so users are able to manage books and materials, It should have book drop box facilities thus the user can do their own actions without the help of others, The availability must be all time because the user's schedule always different hence they could visit the library in their preferable time, Must provide pilotage service to its customer to navigate exact area and Eventually it must contains book tracing functionality so that a user can search a book very easy manner without visiting every area in the library.

In that respect, System A, System B and System C have their functionalities. All three systems have some met functionalities of Table 3 and some are not. If we want to improve all functionalities for the above three systems, we need some hybrids; hence we could obtain all functionalities with a high-level RFID library management system.

Furthermore, according to Table 3, we need to implement functionalities to have a better library system. The number of functionalities needed to implements in System A, B, and are follows:

TABLE IV. NECESSARY AMOUNT OF FUNCTIONALITIES

System	**Number of functionality needed to implement**
A	5

B	3
C	4

According to Table 4, only System B needs less number of functionalities to implement than A and C. System C's necessary functionalities are less than A. Also, System B provides pilotage service with a developed app, which reduces unnecessary wasting time. In that respect, we could identify that System B is one of the best systems among all three systems. Moreover, System C better system when compared with A.

IV. Conclusion and Recommendation

As indicated by all authors and practical systems, we can identify that an RFID-based library management system is a much better system than a barcode and other traditional library systems. Also, this RFID system does not suitable for a small library system because of the cost factor and this usually produces more security, satisfaction and easiness even when it is a new technology. It has overcome almost all problems currently facing in library management.

TABLE V. Recommendation Table

System	Needed Functionality	Way of improving needed functionality
System A	1. Design 2. Technical challenges 3. Stock Management 4. Pilotage services 5. Tracing book	1. Hybrid with system C's design functionality 2. Hybrid with either B or C 3. Hybrid with B's Stock management functionality 4. Hybrid with B's pilotage services functionality 5. Hybrid with either B's or C's functionality
System B	1. Design 2. SMS alert 3. Book dropbox	1. Hybrid with system C's design functionality 2. Hybrid with system A's SMS alert functionality 3. Hybrid with system A's Book dropbox (BDB)functionality
System C	1. SMS alert 2. Stock management 3. Book dropbox 4. Pilotage services	1. Hybrid with system A's SMS alert functionality 2. Hybrid with B's Stock management functionality 3. Hybrid with system A's BDB functionality 4. Hybrid with B's pilotage services functionality

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