USE OF RFID IN UNIVERSITY INSTITUTE OF ENGINEERING AND TECHNOLOGY, PANJAB UNIVERSITY: A SURVEY REPORT

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The present study is an assessment of the implementation process of the RFID system in the University Institute of Engineering and Technology, Panjab University, Chandigarh. The greatest contribution of libraries has been the vast knowledge bank they offer to the seekers like students, researchers, scientists and even teachers and faculty of various knowledge imparting institutions. The process of accessing and consequent effect of RFID implementation was discussed in detail through in-depth interviews with sundry library personnel and users. Simple random sampling method was used. The results reveal that implementation of RFID has enhanced the security system of the library while ensuring faster issue and return of books. The library staff was enabled to perform better with less time consumption, greater efficiency and greater interpersonal support. The benefits accrued to the students were less time at the circulation counter, extended hours for returning books at the book drop station with least help of the library staff. Some hardships were faced by the library staff as some users removed the RFID tags and books returned through 'Book drop' were severely damaged.

Key words: Radio Frequency Identification (RFID) Technology, Library Management Software, user satisfaction, upgradation of libraries, survey, findings and assessment.

INTRODUCTION

RFID as an acronym for Radio Frequency Identification is a technological mechanism that ensures that a library book is identified, accessed, stored, reprogrammed and communicated in the library inventory through usage of radio waves. RFID offers automatic tracking as wireless technology that requires no human intervention. The functionally operational unit is a tag which is used for storing data and which can be retrieved at any time through radio waves. Earlier, RFID was used in libraries only for security purposes. However, gradually the trends changed and the libraries became automated to a large extent. Currently, this technology ensures smooth functioning of issue return, tracking books stock verification and sorting the reading material topic wise, chronologically and even author wise.

Radio Frequency Identification (RFID) is today's fastest growing technologies for increasing efficiencies and improving profitability. RFID is a combination of a computer chip and a small radio antenna that allows almost any object to "self-identify". RFID has a great scope for publishers, distributors for managing the deluge of data flooding them in the form of write-ups cartoons, skids etc, in the distribution chain. It enables each book be able to identify itself along its journey from the warehouse (or the printer) to bookstore, shelf and cash register. The vital aspect of RFID usage is that it has revolutionized library management and practices. Over 70 million library books had been tagged in 2015.

THEORETICAL CONCEPT

To understand the working of the RFID technology it is necessary to examine the essential features of its mechanisms. Components of an RFID system include four main parts:

1. RFID Tags: These are applied directly to items. They contain a tiny chip having capacity of at least 96 bits. The tags are permanently activated (programmed during manufacturing) or, at higher complexity and cost, read-write, both. These tags are electronically programmed with unique information. Their size depends on the size of the antenna. It increases with range of tag and decreases with frequency.
2. Antenna: Also called sensors, interrogators or readers. It serves as a conduit between RFID tags and the coupler. Thus, the RFID antennas connected to the reader, emit power and data to and from the RFID tags.
3. Reader or Coupler: It is the link between RFID tags and the Server/ PC. The coupler sends information in two directions because it reads information from a tag and sends it to the Server or PC in read mode, or it reads information from the Server and sends it to an RFID tag (write mode).
4. Server or PC: Links the coupler and the library automation system. The Server or PC is the heart of a comprehensive RFID system forming the communications gateway among other components. Receiving information from the antennae which exchanges information with the circulation database. It includes a transaction database for producing reports.

The major competitors among the RFID vendors for libraries are VTLS, 3M, with Digital Identification System and Checkpoint's Intelligent Library System. The products on offer are:

Table 1: Operationalization of RFID in Libraries

Sl. No.	Product Offers	VTLS	3M	Checkpoint
1	Tag Manufacturer	TAGSYS	Texas Instruments 1	Microchip
2	Software Developer	VTLS	3M	checkpoint
3	Inventory Technology	RFID	RFID	RFID
4	Security Technology	RFID	EM	RFID
5	Integrated Security Bit	Yes	N.A.	No
6	Query ALS to determine security status	No	No	Yes

Orientation of Libraries through technological inputs within the ambit of RFID has been depicted in table 2.

Table 2: Operationalization of RFID in Libraries

Sl. No.	Details	VTLS	3M	Checkpoint
1	Tag Type	Passive	Passive	Passive
2	Read / Write or WORM	Read/ Write	Read / Write	write once, read many (WORM)
3	Memory Size	74-bits	256-bits	96-bits

The tasks accomplished and appraisals of their varied levels of performance can be assessed on the basis of the parameters given in table 3. The comparative analysis of three orientation systems has also been presented.

Table 3: Operationalization of RFID in Libraries

Sl. No.	Description of Tasks	VTLS	3M	Check point
1	Read speed (in books per second)	20	2	20
2	Time to inventory 250k collection	3.5 hours	3.5 hours	3.5 hours
3	Time to find 100 books in 10k collection	8 minutes	83 minutes	N.A.
4	accepting downloads for weeding and other activities	Yes	Yes	No

THE UNIVERSITY INSTITUTE OF ENGINEERING AND TECHNOLOGY (UIET) AND IT'S LIBRARY

The University Institute of Engineering and Technology (UIET), was established in 2002, as a premier institution for engineering in the Panjab University, Chandigarh. The UIET Library has a collection of over 22,000 books and 418 E-books. The library has access to about 5000 online full-text journals like IEEE, Science Direct, Springer, ASME, Wiley, Taylor & Francis and Emerald through the interconnected Central Library. The UIET Library collection can be searched over Web-OPAC which is an Online Public Access Catalogue. The main software opted for is the SLIM Software which was installed in the year 2013. This software is being used for most library related activities like issue and return, classification, cataloguing, stock taking and OPAC. It has been a great attraction for users visiting the library. In fact, the UIET library is the first departmental library of Panjab University to implement the RFID based system since 2016. The chief functions popularly used in the library are:

1. Self-check out/ check-in system
2. Detection of unissued books
3. Books going out of the library without permission
4. Book-Drop Station provided at library entrance for return of books.

The library users can drop their issued books at the dropping station and obtain print receipts. Radio Frequency Identification (RFID) is one of the most exciting technologies that revolutionized the working practices by increasing efficiencies and improving profitability. The paper gives details about RFID, its components, working, and usage in different sectors i.e. retail sales and supply chains, livestock industry, courier services, military and prisons, automobiles and logistics, entertainment industry, publishing industry, wireless transaction especially in libraries. It presents an indepth analysis of RFID usage in libraries with an implementation road map along with its impacts on libraries.

REVIEW OF LITERATURE

To obtain an understanding of the use of RFID in libraries a concise review of the available literature on the subject has been conducted by the author. Kumar et al. (2014) explain the different components, the process of RFID working and the provision of RFID solutions to minimize the operating costs, improving automation, improving the tracking system and preventing loss of resources. They examine the future of RFID technology in Indian libraries. Pal and Sharma (2017) describe the future of Radio Frequency Identification (RFID) technology for the smooth functioning of library operations and ensuring better security. They highlighted the major issues faced during the implementation and also the measures to be taken for installation.

Sevukan and Vijay Kumar (2015) evaluate the implementation of the RFID system and concluded that many shortcomings like safety and security of library assets, manpower requirement, lack of speed, reliability etc. were overcome by its implementation. Madhusudhan and Gupta (2014) discuss the use of RFID technology by the students in their institute revealing that most library users were satisfied with it as it promoted fastest circulation, self-check in and checkout besides the drop box facility. Khanna (2014) conducted a study on the impact of RFID in terms of automated check in and checkout, stock verification, staff, services and equipment and suggested that it was time saving and efficient. Pawar and Rodge (2012) discuss the National Information Standards Organization Circulation Interchange Protocol (NCIP) standards that were directly linked to the development and problems of the RFID systems in the library. The basic issues were related to maintenance of hardware, support, LMS compatibility, privacy and standardization. Surulinathi and Chudamani (2011) explain RFID technology as a unique automatic data capturing technology or AIDC. Libraries were adapting to this as it gave them a sense of security, convenienceand user satisfaction. Somvir and Kaushik (2011) outline the overview and structure of RFID technology, its functioning, merits and demerits and also provided suggestions on how it was beneficial for libraries security.

Mehrjerdi (2011) highlights the risks involved in terms of high installation and infrastructural costs, skilled workers, user issues and security of the data besides explaining the benefits like information management, efficiency of circulation operations, improved inventory control, accurate data and reliability along with theft control. Pandey and Mahajan (2010) explain that the RFID tag contained the relevant information which was easily detected by the RFID reader. Madhusudhan (2010) explained the usage and implementation process of RFID technology at the Indian Law Institute Library (ILIL) and National Social Science Documentation Centre Library (NSSDC), New Delhi. Galhotra and Galhotra (2009) stated that the RFID system could be integrated with the available LMS in the library to improve the library work like stock verification, location of the book and increase in the quality of service provided to the Library users. Ward and Kranenburg (2006) point out a number of relevant RIFD related issues existing in libraries. Selamat and Majlis (2006) show that the self-issuing station decreased to a minimal the requirement for library staff at the

circulation counter while circulation process was fully automated allowing library staff to focus on providing effective services to the users. Kern (2003) feels that the library used RFID for Self issuing, Book detection, Stock Verification and sorting of library material saving time and efforts of the library staff making the library fully user centric. Thus, the review of literature brought out how various scholars had dwelled on the concept of RFID, their components, merits and demerits of application.

RESEARCH GAPS

The research gap, however, was that none of the scholarly works addressed the vital aspects of practical usage of RFID technology. Most of the case studies taken up have consistently suggested that improvements be taken up in the library services after implementation of RFID technology. The future of the library stands on implementation of RFID Systems for obtaining this vital leverage the Indian University libraries as well as public and private libraries. To address this vital gap, it is essential that the case studies of all libraries implementing RFID be undertaken to pinpoint the requisite direction and magnitude of the overall implementation process of libraries in India.

RESEARCH QUESTIONS

This paper looks at the emergence of upgraded library use through feedback obtained from the users. The research queries that provoked the inspiration for this study were:

1. The extent to which Indian libraries have accepted the RFID technology.
2. The extent to which Indian libraries adopted to RFID use.
3. How many libraries have been successful in using the full potential of libraries in India?
4. What are areas that can be improved upon?
5. What is the overall impact of RFID implementation in university libraries across the county?

OBJECTIVES OF THE STUDY

The search for answers to the research questions led to the framing of the following objectives:

1. To determine the awareness about RFID usage among UIET Library users;
2. To ascertain the intensity of utilization of RFID;
3. To analyze user's dependency on RFID technology; and
4. To enumerate the problems with regard to RFID usage at the UIET library.

METHODOLOGY

To achieve the said objectives a survey approach was adopted to obtain the views of the students and research scholars of UIET. The sample selection was done on the basis of Simple Random Sampling Method. A structured questionnaire was used as an instrument of enquiry to conduct the investigation. The responses were received from 100 users. As the study was conducted during the initiation of the RFID utilization in the library only 100 respondents were considered for the survey. These respondents include research scholars and faculty members who were regular users of the

library facilities. Among these users 25 per cent sample was taken on any given working day. Two Focus Group Discussions (FGDs) were also held among other users. The FGDs had 25 participants each. In depth interviews conducted on an informal approach were also conducted. The collected data was collated and tabulated for analysis and interpretation.

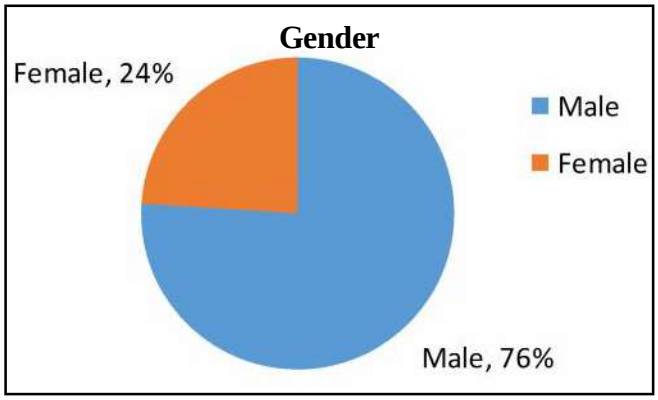
RESULTS AND DISCUSSIONS

A summation of the results and their analytic interpretation is presented to showcase the findings of the study. Certain demographic features were looked into to obtain a socio-cultural economic grounding of the respondents as it was considered a significant part of the response cycle of various participants.

Gender distribution of Library Users

It can be seen from the Figure 1 that there was a distinctive gender wise distribution of library users as the males were almost three times the proportion of the females. Awareness on the use of RFID systems varied among the male and female users. The male respondents were 76 per cent and the female respondents were 24 per cent of the sample. A marked dominance of male respondents in the sample as compared to the female respondents could possibly lead to skewed responses. However, the in-depth interviews would probably balance the trends in usage of library resources and information on the awareness of RFID. This gender segregation was significant to understand the reasons for women not coming forward to try new technologies.

Figure 1: Gender distribution of Library Users



Age wise distribution of Library Users

The distribution according to the age of the library users has been depicted in age groups as shown in table 4. The highest proportion of users (30%) falls in the age group between 18 and 19 years old with 20 percent being in the 20 years old age group. There were 8 percent who were in the age group of 21years old and 24 years old each while only 2 percent of the users were in the age groups of 22 years old and 26 years old.

Table 4: Age wise distribution of Library Users

Sl. No.	Age	No. of respondents	Percentage (%)
1	18	30	30.0
2	19	30	30.0
3	20	20	20.0
4	21	8	8.0
5	22	2	2.0
6	24	8	8.0
7	26	2	2.0

Academic Background of Library Users

When examining the educational background of the library users participating in the study it was observed that they could be divided into two groups as show in table 5. The maximum numbers of users participating in the study were enrolled in Undergraduate courses. A

smaller proportion of them were studying in Post graduate courses or were research scholars pursuing their doctoral research. This shows that a larger number of the younger participants in the study were aware of the RFID mechanism while the seniors or older were not as aware.

Table 5: Academic Background of Library Users

Sl. No.	Educational Qualification	No. of respondents	Percentage (%)
1	Under Graduate (Bachelor of Engineering)	86	86%
2	Post Graduate (Masters of Engineering)	8	8%
3	Research Scholars	6	6%

Frequency of visit to the Library

The table 6 shows that a majority of the users visited the library frequently. In fact, 46 per cent of them used it weekly while 28 per cent visited it daily. There were 8 percent of them who visited library every month and 8 percent reported that they visited the library on a fortnightly basis and 10 percent said they visited it only occasionally. These findings indicate that library visits depended largely upon the services provided by the library i.e. newly installed RFID based applications like Self Check out, Book Drop Station, Wi-Fi facility to search the e-contents in their respective fields etc. were greatly favoured by the participants in the survey.

Table 6: Frequency of visit to the Library

Sl. No.	Frequency of Visit	No. of respondents	Percentage (%)
1	Daily	28	28%
2	Weekly	46	46%
3	Fortnightly	8	8%
4	Monthly	8	8%
5	Occasionally	10	10%

Purpose of Library Visit

The questionnaire featured five options when querying for the purpose indicated for the use of library by the library users. The responses showed that the largest proportion went to the library to prepare for their examinations, followed by those who wanted to benefit from the library newspapers and magazines circulation. These were also a sizable proportion who came to use the Wi-Fi facility and keep up to date with the latest trends and techniques. These trends are shown in Table 7.

Awareness of RFID components installed in the Library

The table 8 gives an overview of the awareness levels of the participants in the survey of the RFID technology. It was observed that a majority of the respondents i.e. 66 percent were aware of the book drop facility provided by the

Table 7: Purposes of Library Visit

Sl. No.	Purpose	Never	Rarely	Sometimes	Often	Always	Median	Std. Deviation
1	Preparation for examination	6.0%	4.0%	24%	44%	22%	3.7200	1.05056
2	Issue or return of library borrowed material	4%	18%	18%	28%	32%	3.6600	1.22241
3	Reading newspaper & magazines	18%	24%	26%	14%	18%	2.9000	1.35902
4	Gain awareness on current affairs and keep up to date	22%	22%	40%	16%	0	2.5000	1.01519
5	To use Wi-Fi facility	36%	12%	36%	8%	8%	2.4000	1.27775

library, while 14 percent were somewhat aware of the facility. When talking about the provision of security gates, 38 percent of the users were fully aware of this existence but in contrast were 20-22 percent of the users who claimed that they only somewhat aware. These were 24 percent of the users of all categories, who were slightly aware of RFID tags, followed by 22 percent who were only somewhat aware. There were 20 percent of the respondents who were significantly not at all aware of the RFID tags. The data indicates that there are wide gaps in the awareness levels of the participants in the survey and is representative of the general lack of information on the subject.

Source of Information of RFID facility available at UIET Library among Users

The table 9 shows the responses of the participants in the survey on the query of how they came to know about the RFID facility at the UIET. The findings show that 42 percent of the users obtained guidance about the RFID system installed in the library from the librarian, whereas, 28 percent had heard about it from their friends and colleagues. However, 26 percent of the users got the information of this technology on the spot and at the library when they used it themselves. There were 4 percent who got the information from other sources like news paper clippings etc. It can be inferred, thus, that the maximum number of respondents should have obtained guidance from the librarian on the RFID facility

Usage of RFID Components in the Library

The table 10 shows that 52 percent of the users always used the Book Drop facility available in the library, followed by 26 per cent who used this often but only 12 percent of the respondents used it sometimes. There were 8 percent of the respondents who said that they rarely used this facility of the library. Thus, it can be inferred that half the users were aware of this component and used it but there were a significant proportion who did not use it. Therefore, there was a need to organize more orientation programs in the library for spreading awareness on the better utilization of this time saving application.

Table 8: Awareness of RFID components installed in the Library

Sl. No.	Awareness of RFID Components	Not at all Aware	Slightly Aware	Somewhat Aware	Moder-ately Aware	Extremely Aware	Median	Std. Deviation
1	Book Drop	2%	4%	14%	14%	66%	4.3800	1.00793
2	Security Gates	-	4%	42%	16%	38%	3.8800	098229
3	RFID Tags	20%	24%	22%	18%	16%	2.8600	1.37039

Table 9: Source of Information of RFID facility available at UIET Library among Users

Sl. No.	RFID Facility	Librarian Guidance	Friends/ Colleagues	On the Spot	Other Sources	Median	Std. Deviation
1	Information	42%	28%	26%	4%	1.92	0.922

Table 10: Usage of RFID Components in the Library

Sl. No.	Usage of RFID Component	Never	Rarely	Sometimes	Often	Always	Median	Std. Deviation
1	Book Drop/ Automated system for self -return of documents	2%	8%	12%	26%	52%	4.1800	1.06311

Limitations in the use of the RFID System

The participants in the survey were asked about their views on the limitations of the RFID System. Their answers have been shown in table 11. The problems enumerated by them showed the frequency of False alarm at the security gate, missing Tag, slow speed of the system, problems faced while using the book drop facility etc. Thus, the findings show that there are several flaws that need to be taken care of before the benefits of the RFID can be fully availed of.

Effectiveness of RFID Technology in Library Services

The table 12 shows that the RFID application has been effective in several ways for the library services at the UIET. There were 60 percent of the users who responded that they 'strongly agree' with the usage of RFID technology, as it was responsible for the simplification of issue and return services, while 58 percent of the respondents feel that the library image had improved considerably due to the introduction of this technology and 52 percent responded that the RFID system was very user friendly. There were 50 percent who felt that returning the library material had become much easier and did not require any assistance. Thus, a large proportion of the respondents were satisfied with their usage of the RFID technology.

Table 11: Limitations in the use of the RFID System

Sl. No.	Limitations of RFID System	Never	Rarely	Sometimes	Often	Always	Median	Standard Deviation
1	Slow speed	44%	26%	18%	10%	2%)	2.0000	1.10657
2	Return slip printer not working	46%	26%	18%	16%	2%	1.9400	1.07684
3	Tag missing from document	54%	28%	16%	2%	-	1.6600	.82338
4	SMS not received on time	70%	10%	8%	10%	2%	1.6400	1.12050
5	Problem of false alarm at the security gate	70%	16%	8%	4%	2%	1.5200	.95276
6	Book returned but still showing in account	76%	10%	8%	6%	-	1.4400	.88433

Table 12: Effectiveness of RFID Technology in Library Services

Sl. No.	Effectiveness	RFID Application in UIET Library						
		Strongly Disagree	Agree	Neither agree nor disagree	Strongly agree	Disagree	Median	Std. Deviation
1	Return of documents without taking assistance of Library staff	-	30%	14%	50%	6%	4.2400	.91607
2	Reduction of time to perform issue and return functions	-	20%	18%	60%	2%	4.3800	.85452
3	Simplification of the issue and return services	4%	26%	10%	60%	-	4.4200	.83520
4	Improvement in Image of Library	-	26%	14%	58%	2%	4.4000	.80812
5	Effective issue and return services	2%	32%	6%	60%	-	4.4800	.78870

Satisfaction Level while using the RFID System

The table 13 shows the satisfaction level of the survey participants with the RFID application and their views on how user friendly the application was for them. They were asked to rate the services rendered by the library on the Likert scale ranging from very satisfied to unsure. It was observed from the results that 50 percent of the users are very satisfied with their usage of this system and were followed by 36 percent who were satisfied but 14 percent of the users were unsure about the application. There were 36 percent who would be very satisfied in the future with further exposure to the RFID mechanisms. There were 14 percent who required further orientation to make them aware and fully satisfied with the RFID system. These responses clearly demonstrate the fact that the users valued the RFID services operational in their library. Thus, a majority of the users were very satisfied with the implementation of RFID technology in the UIET Library. These users were almost totally aware of the RFID components and used them on a regular basis. This result translates into the success of the implementation of RFID in the UIET library.

Table 13: Satisfaction Level while using the RFID System

Sl. No.	Satisfaction Level of RFID	Very Satisfied	Satisfied	Unsure	Median	Std. Deviation
1	Satisfied with the RFID system	50%	36%	14%	1.6400	.72168

Salient features of the RFID advantaged libraries are-

1. The new technology has tremendous potential for multiple applications in the future.
2. A flexible technology which combines security and item identification in the same tag reducing library losses by the provision of effective library detection systems.
3. Works efficiently on a materials sorting system that automates check-in and check-out processes.
4. RFID eliminates numerous manual and error making processes. Self-check machines are extremely user-friendly. Multiple items are checked out by simply passing books over a scanner.
5. Library staff would be able to perform direct patron information services rather than repetitive circulation transactions once the RFID technology is implemented.
6. Efficient and accurate Wireless inventory management is 20 times faster
7. Better availability of books and other library resources as the database is updated in real time.

CONCLUSION, SUGGESTIONS AND RECOMMENDATIONS

The implications of RFID were evaluated through in-depth discussions with all personnel involved in the planning and implementation of RFID. To conclude, RFID has been recognized as a fast-growing technology to be used in libraries. RFID technology usage is expanding fast and, therefore, all libraries should adopt this technology to improve their services and obtain the multiple advantages offered. The advent of

RFID has changed the entire face of the library services and galvanized user satisfaction levels with the higher institutional libraries in particular. The onus of responsibility now rests with the librarians to promote awareness among the users.

RECOMMENDATIONS

On the basis of the findings the following recommendations are suggested:

1. Eliminate issues of false alarm at security gate. Librarian should discuss such aberrations with the supplier about positioning the gate and tag detection range. Security gates should be located away from any metal door and 8 to 10 feet away from the computer.
2. Library staff should mark the tagged collection to easily detect untagged document.
3. To overcome the problem of damaged books returned through the book drop station, it is suggested that the library staff manually check the books returned through book drop station.
4. Users should be constantly oriented and updated on the newer technology available.
5. Feedback should be taken periodically from users for improvement of the use of the technology.
6. Library should use a secure mode of connection for uninterrupted communication between Library Management system and the RFID components.

Plan of Action for RFID Implementation in Libraries

1. A privacy policy must be developed and put in place for implementation of RFID.
2. The library must make its policies and practices publically dispersed on the use and maintenance of RFID systems, encompassing tags, readers, and the associated database(s).
3. All library users must know the purposes for which tags and readers are used.
4. Auditable security with integrity in transmission, databases and system access, along with the use of encryption. The installation of an RFID-based system, results in high costs and time-consuming structural changes so that the library can successfully use the new system.

This study highlighted the fact that a majority of the users were satisfied with the implementation of the RFID technology in the UIET Library as the users were almost aware of the RFID components and were using them on a regular basis. This was recognized a great need among the users who were not aware of this facility in the Library to be immediately oriented through frequently organized awareness and orientation programs. At this nascent stage of RFID use the entire library community must take up a comprehensive technology assessment of RFID to enable librarians for making astute decisions for the implementation of this technology. The library community is the ordained repository of intellectual freedom and user privacy. Libraries are indispensable human knowledge reservoirs. Currently the libraries must use this technology with great responsibility and from an informed stance of the librarians and users alike.

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