Riwayat

Original Article

Implementation of Smart Library Using Radio Frequency Identification (RFID) Technology in Libraries

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Abstract:

A library is a collection of information, resources, books, and services, and the structure in which it resides. To improve the quality of service and the efficiency of operation of new technologies is always of interest to librarians. Libraries are at the forefront of successfully implementing RFID technology, reducing the time and staff required for book circulation and simultaneously increasing hourly book transactions. RFID is a new generation technology of Automatic Identification and Data collection that helps to automate library processes and allows the identification of a large number of marked objects such as books, using wave radios. The proposed system is based on RFID readers, supported with antennas in the gate and transaction section, and library cards containing RFID transponders capable of storing information electronically that can be read/written even without physical contact with the help of radio media.

Keywords: RFID, Management System, Library, Smart Library

Introduction

Radio Frequency Identification (RFID) is a rapidly evolving technology that provides wireless identification and tracking capabilities. Today, many applications such as preventing car theft, merchandise, tracking items on libraries, etc., utilize RFID systems. This section provides an overview of RFID technology and includes a brief explanation of the main operating frequency ranges, as well as a brief history of RFID and market trends.

https://jurnal.usk.ac.id/riwayat

Received: Januari 12, 2024 – Revised: Februari 15, 2024- Accepted: Maret 18, 2024 - Published online: April 30, 2024

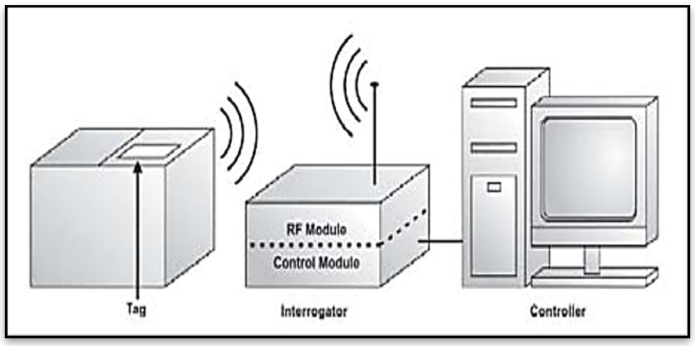

Figure 1. Typical RFID System Scheme

RFID is generally characterized by the use of a simple device at one end, called a tag or transponder and a more complex device at the other end of the link called a reader or interrogator. A transponder consists of an antenna and an integrated application-specific circuit (ASIC) chip that contains the memory on which data is stored. Sometimes, they may include a matching network, located between the antenna and chip, to achieve precise impedance matching. The reader consists of an antenna, an RF electronic module, which is responsible for communicating with the transponder and an electronic control module, which is responsible for communicating with the host computer (or controller), usually connected to the reader to process incoming information centrally.

Figure 1.1 shows the schematic of a typical RFID system. RFID systems can only be read (data is transferred in one direction, from the transponder to the reader) or read and write (two-way communication). Transponders can be powered by batteries (active transponders) or by repairing radio signals sent by readers (passive transponders).

The first attempts to introduce radio frequency identification technology in libraries began in the mid-1990s. RFID technology is aimed at improving the overall workflow in the library as much as possible and making everything from book publishing to book return automatically. The pioneer in this regard was the Company 3M (USA), which since the late 1990s began to produce and install radio frequency systems in libraries. Singapore was the first country to introduce RFID in libraries and Rockefeller University in New York was the first academic library in the US to utilize this technology. Farmington's community library was the first public institution to use RFID technology. In Europe, the first public library to use RFID was Hoogezand-Sappemeer, Netherlands, in 2001, where borrowers were given a choice. It is proven in surveys that 70% of people are adapting to RFID technology.

For Indonesia, this technology has been used since the 2005s. Libraries had to find creative solutions to stay relevant to user needs and RFID quickly became popular for efficient management in large libraries. Significantly, the use of RFID reduces the time required for stock circulation and verification operations. The most remarkable time savings are due to the fact that information can be read from RFID transponders much faster than from barcodes and some others. RFID is primarily aimed at transforming from partially automated library systems to fully automated and also offers great potential to expand access to library services and security in ways never felt before.

In line with the Vision & Mission of STMIK Pesat Nabire Papua, the implementation aspect of smart campus development, especially in the library management system process at STMIK Pesat Nabire Papua, in principle, development can be done starting from the development of adequate Internet Infrastructure. The purpose

of this paper is to improve smart campus services, especially in the library management system process as one of the mandatory needs of universities in organizing quality student reading interests.

After developing a system in barcode identification, a new technology emerged with the name RFID (Radio Frequency Identification) which is very rapidly advancing. RFID is a technology that is very useful and has strengths and advantages or also called "powerful emerging technology" because an institution or university can achieve the totality of a service and management. An institution can be more optimal in business processes and reduce operational costs with RFID technology when knowing the identity, location, condition of assets, tools, others. For this reason, an institution can be more optimal in business processes and reduce operational costs supported by RFID technology.

According to Addepalli (2014) revealed that with the existence and use of RFID, a process in circulation, for example borrowing books and returning books, can be done directly using library information systems and is no longer done manually.

According to Sahoo & Sharma (2015) said when making a book loan transaction and returning a book can be more efficient with the RFID system in the library in order to improve services to visitors. In manual bookkeeping when managing a data is very ineffective and efficient because it manages a large amount of data, for that a large-scale data management system is needed.

Methods

Information Needs Analysis

Library as a source of information is a supporting part in developing national education, especially developing interest in reading for the entire community. Library development in this case is the improvement of resources, services and library management.

Running Library Business Processes

At this time STMIK Pesat Nabire has a library, where the library is used not only for campus but elementary, junior high and high school Rapid Nabire, the location of the library happens to be surrounded by elementary schools, junior high schools, high schools and STMIK Rapid Nabire, with average visits to the library as follows:

Table 1. Library Visit Data

Visiting Personnel	Average Personnel Visit to Library						
	Your	Selasa	Wednesday	Kamis	Friday	Saturday	WAR - WAR
STMIK Students Rapid	14	11	13	19	18	17	**15**
Rapid High School Students	17	15	11	13	12		**14**
Rapid Junior High School Students	11	9	13	16	11	**HOLIDAY**	**12**
Rapid Elementary School Students	6	5	7	9	7		**7**
AVERAGE PER DAY	**12**	**10**	**11**	**14**	**12**	**17**	

Data source: STMIK Pesat Nabire Library 2021

Library visitor data is quite small when compared to the total students and students in the Rapid Nabire Foundation. The data of students and students at the Rapid Nabire Foundation are as follows:

Table 2. Number of Kindergarten & Elementary School Students Rapid

Foundation for Rapid Education	Number of Students Year 2022
Children's Park Elementary School	**17 People**
Class 1A	34 People
Class 1B	32 People
Class 2A	36 People
Class 2B	34 People
Class 3A	32 People
Class 3B	30 People
Class 4A	38 People
Class 4B	36 People
Class 5A	36 People
Class 5B	32 People
Class 6A	36 People
Class 6B	36 People
Total Elementary School Students Rapid	**412 People**

Table 3. The Number of Junior High School Students Is Rapid

Foundation for Rapid Education	Number of Students Year 2022
Class 7A	36 People
Class 7B	36 People
Class 7C	36 People
Class 8A	36 People
Class 8B	36 People
Class 8C	36 People
Class 9A	36 People
Class 9B	36 People
Class 9C	36 People
Total Junior High School Students Rapid	**324 People**

Table 4. Number of High School Students Rapid

Foundation for Rapid Education	Number of Students Year 2022
Class 10A	36 People
Class 10B	36 People
Class 10C	34 People
Grade 11 - Social Studies 1	36 People
Grade 11 - Social Studies 2	36 People
Grade 11 - Science	32 People
Class 12 - Social Studies 1	36 People
Class 12 - Social Studies 1	34 People
Grade 12 - Science	30 People
Total High School Students Rapid	**324 People**

Table 5. Number of STMIK Students Rapid

Foundation for Rapid Education	Number of Students in 2022
Class of 2019 - 2020	24 People
Class of 2020 - 2021	30 People
Class of 2021 - 2022	36 People
Class of 2022 - 2023	42 People
Total STMIK Students	**132 People**

The data on the number of students and students that the author conveyed above was obtained directly from the Rapid Nabire Foundation with the latest data in 2022. With so many students and students in the Rapid Nabire Foundation, it is very possible that the level of activities in the library can be very high, if the foundation makes a breakthrough that increases the reading interest of students and students in the Rapid Foundation.

With the existence of library activities where the exit and entry of people is so high, it is often found that some abuse occurs in the library, either by visitors or library employees. Therefore, the author has analyzed several abuses that often occur in the STMIK Pesat Nabire Library, among others, as follows:

Table 6. Asset Abuse

Example of Abuse (Fraud)	Information
Asset Damage	Data, Facilities, Documents, and Library Support Tools that may be tampered with
Asset Theft	Theft/loss/unauthorized transfer of Library-related Data, Facilities, Documents, and Tools
Asset Modification	The Library's Data, Facilities, Documents, and Support Tools may be modified in ways that unauthorized persons should
Disruption of Operational Continuity	Disruption of daily library operations when unwanted things happen, for example: lights out, etc
Asset Abuse	Computer equipment, data, facilities, documents, and library support tools are used for unauthorized personal use
Physical Harm	The occurrence of *physical harm* to library employees that has an impact on personnel experiencing physical suffering or injury

Based on the problems in table 3.6, the author concludes that asset security in libraries is very important, especially for the purpose of safeguarding assets. Asset security is one form of internal control in the Library Organization. The security of these assets is closely related to library assets at STMIK Pesat Nabire.

Data Collection Methods

Data collection conducted by the author uses the direct observation method where several problems have been found as the author discusses in table 3.6 and the interview method (interview) on library activities, the person in charge of the library and students who often borrow books in the library and several office boys who helped clean the library.

Results

Cycle/Work of RFID Systems in Libraries

The RFID work system that will be applied at the Nabire Rapid STMIK Library, as shown below:

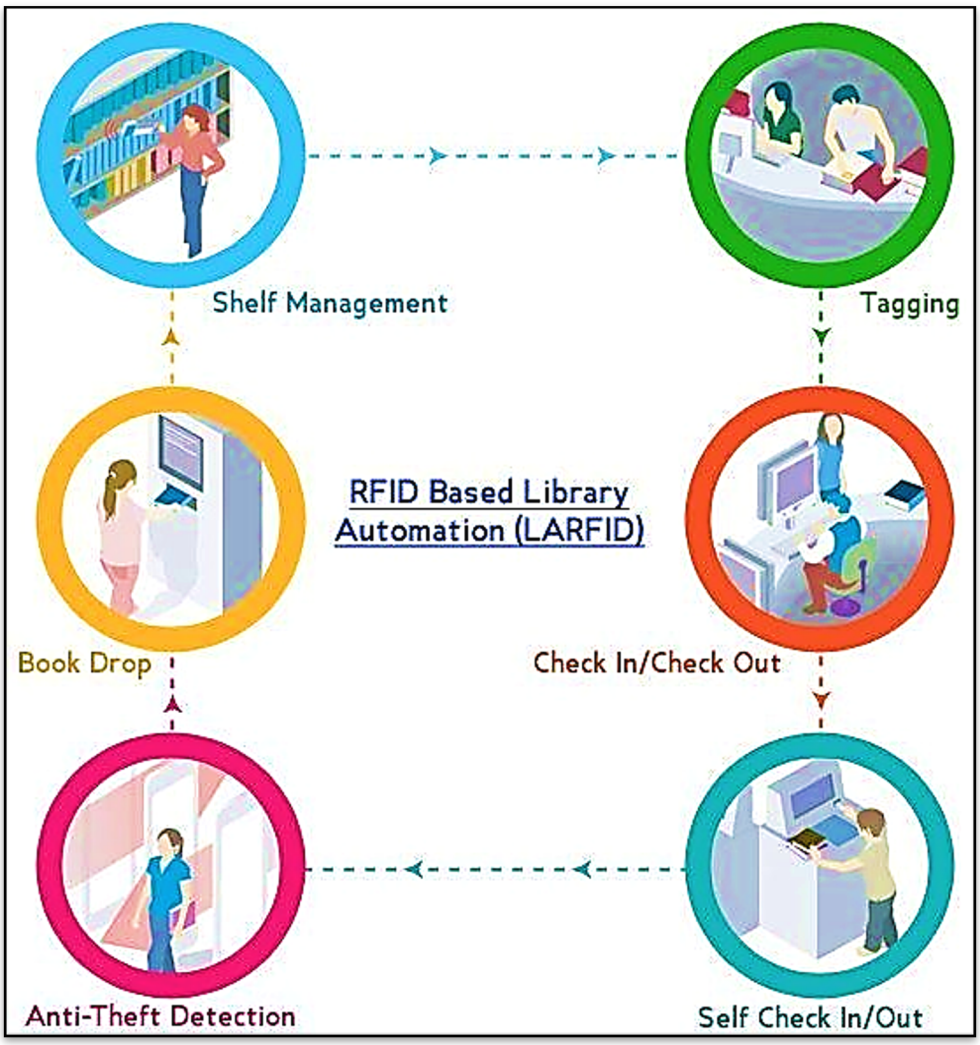

Figure 2. Working RFID Systems in Libraries

RFID tags that can be stickers, paper or plastic of various sizes. Inside the tag there is a chip capable of storing a certain amount of information, the second is an RFID terminal reader, consisting of an RFID reader and an antenna that will affect the optimal distance of identification. The RFID terminal will read or transform the information stored in the tag through radio frequencies.

When the tag performs identification, the information stored on the chip in the tag is re-encoded by the reader and stored, sent to the server. When there is no server, most of the software is stored in the reader. The RFID terminal is directly connected to the host computer system, which regulates the flow of information from items detected within the scope of the RFID system and regulates communication between the tag and the reader. The host can be a stand-alone or connected to a LAN / Internet network for communication with the server. Types of reader conversions include, staff workstations for circulation desks to perform work, self-protective charging and

discharging stations, readers to identify returned library materials and sensor doors to identify security.

The RFID system in STMIK Pesat Library is a combination of several components. Some of these components will create workflow mechanisms in libraries that make the library different from other libraries that do not use RFID systems. Then here are the steps:

- ✓ Input the book description into RFID tags.
- ✓ Paste the RFID tag into the book.
- ✓ Put the book on the shelf.
- ✓ Scan books with a handheld scanner to make shelving easier.
- ✓ Pemustaka searches for library materials in OPAC and searches to the shelf range.
- ✓ Then the loan is carried out independently (*self service*) using a *self check station* tool.
- ✓ Books borrowed that have gone through the above process will not be a problem when passing through the gate where a security alarm has been installed.
- ✓ When users want to return books, they can go through the *book drop tool*.

The application of RFID in libraries is the addition of the latest technology used in libraries for the combination of automation and security activities in document maintenance either inside the library or when documents are outside the library. RFID is the latest technology for use in library material theft/loss detection systems.

System Requirement of Implementing RFID System

Figure 1 is an ideal condition where the library automation process should entirely run using RFID-based equipment. Each library collection will be fitted with RFID tags and programmed with *barcode* information on each collection by library staff. Followed by the installation of tools at circulation desks, safety gates, self-lending platforms, self-returns, library collection re-collection helpers with independent RFID tools. Before getting to that, there needs to be a detailed system requirement for RFID system needs, among others, as follows:

Tabel 7. System Requirement RFID

No	Tool Description	Sum
1	**Circulation Assistant, High Power**	1 Unit
	Functions to turn computer terminals in the library into processing devices / RFID circulation devices.	
	RFID high power circulation assistant is used as a reading and write tool (programming) RFID Tags and can be connected directly with library management software systems easily.	
	Can switch between borrowing and returning modes automatically, depending on the library application.	
	The detection zone of this circulation assistant antenna is 100 mm around the pad and 350mm above and below the pad.	
2	**RFID RaceTrack Tags (@roll = 1000 pcs)**	5 Roll

No	Tool Description	Sum
	It uses a 2CQR chip with a RaceTrack strapless joint antenna. Minimum amount of programmable memory is 0.5k-2.5k bits. Antenna dari Aluminum, Tag Base Material dari PET (Polyethylene Terephthalate). Works at a frequency of 11.56 MHz. The size of RFID Tags is 49mmx81mm. All RFID Tags must be secured for 40 Years from the item to which the tag was first used/affixed. RFID Tags must have a minimum of 4 *welding points* and the electronic chip of these tags must not be placed under or on the bridge of the antenna tag.	
3	**Security Gate**	1 Unit
4	**Personal Computer**	1 Unit
5	**Router**	1 Unit
6	**Acces point long range**	2 Units
7	**UPS**	4 Units
8	**Barcode Scanner**	3 Units
9	**Application Window server 16**	1 Unit
10	**Library energy**	2 Persons
11	**Data integration, Sport technical, maintenance**	1 Year
12	**Print Membership card**	-

RFID technology finds ethical issues for librarians. RFID technology enables greatly enhanced services for users, especially in the areas of circulation and theft detection. It also allows for more efficient use of professionally trained staff and can reduce manpower from libraries. So librarians have taken extra steps to implement this type of system for the development of library services.

Benefits and Challenges of Implementing RFID

RFID systems began to be used in libraries in the late 1990s whose uses include not only detecting the loss of library materials, also accelerating staff performance and implementation, simplifying and supporting the speed of staff affairs and implementation and implemented for the purpose of tracking document efficiency throughout the library, simplifying and speeding up the use of documents, security of library materials, inventory, verification and handling on shelves (Boss, 2009).

After implementing RFID, users can easily and quickly take out and return books through self-edition return kiosks and users are very comfortable with this. Various tasks of library staff such as searching for library documents, re-shelving books that are better shelf management. Library material inventory is faster and more

accurate than ever, anti-theft detection is made easier using this system. RFID gates track all document and user movements. It has made the daily tasks of the library easier.

RFID provides significant advantages when compared to the use of *barcodes* in libraries. The main advantage is the improvement of service quality and savings in operational costs of library personnel, because RFID technology allows library users to perform *self-service* both borrowing and returning library materials using membership cards that have been planted with RFID chips commonly called *smartcards*.

In applying new technology, there will be positive and negative aspects, as well as in a library, there will be advantages and disadvantages of RFID technology, including:

- ✓ Charging/discharging speed, the use of RFID reduces the amount of time required to perform circulation and invent-tarization activities because RFID tags can be read remotely.
- ✓ Time saving, attributed to the facts information that can be read from RFID tags is much faster and multiple library materials in the stack can be read at the same time.
- ✓ Facilitating self-service, the sensor can read RFID tags that have been installed in several borrowed or returned library materials at the same time.
- ✓ High reliability, RFID systems connect sensors for exits and circulation systems to identify items leaving the library as well as minimize theft and cost savings.
- ✓ Inventory at high speed, the ability to scan library materials on shelves without pointing them out or deleting them.
- ✓ Automatic material handling, including sorting library materials by category to be placed in unused places.
- ✓ RFID tags last longer than barcodes due to the absence of direct contact to the item.
- ✓ Rapid circular activities.

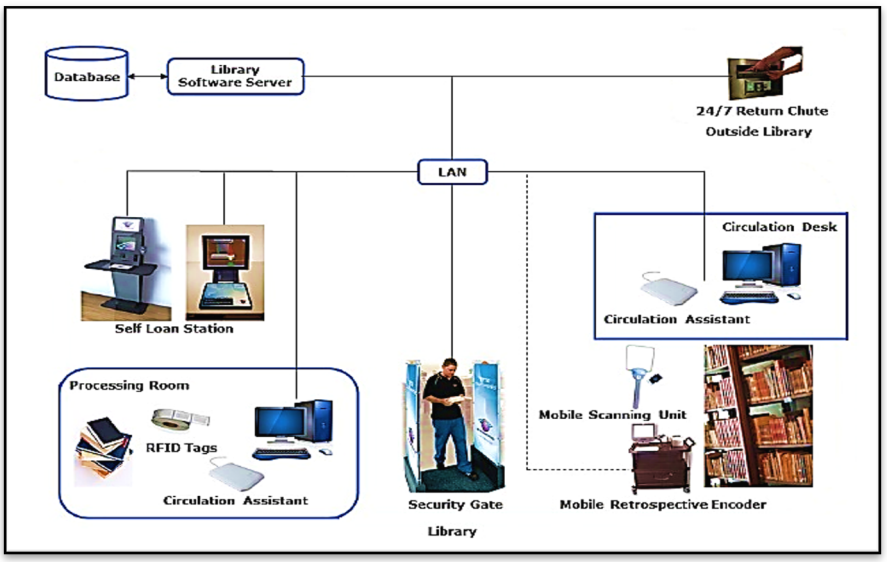

Figure 3. RFID Topology in Library

Besides the advantages, it cannot be separated from the disadvantages of using RFID

in libraries, some of the disadvantages are

- ✓ The costs incurred for the purchase of RFID components are high.
- ✓ RFID is prone to compromise because the foil layer of the tag that is too thick could possibly block radio signals and allow cancellation of those signals.
- ✓ Possible deletion/ retraction of installed tags that are on items (library materials).
- ✓ The problem of the sensor comes out, the sensor door must read twice the distance of other readers, meaning that even from a distance, the sensor must be able to perform its function.
- ✓ Threats to privacy, The presence of personal information of users recorded on RFID tags (*smart cards*).

RFID Library Implementation

Here are the details of each stage in the implementation process:

1. Installation Development of RFID equipment in the library (1–5 days), Installation of all library RFID tools as needed accompanied by training on how to use.
2. Training on the use of all RFID-based library automation tools for library staff along with training on the use of tools and their use integrated with library applications (if any).
3. Training on the use of all tools for library staff (2 days).
4. Installation of RFID race Track Tags per book.
5. Enter book data into RFID race Track Tags.

Evaluation and Improvement

System evaluation based on internal control components is described in the table below.

Table 8. System Evaluation Based on Internal Control

No	Control Components	What To Do
1	**Control Environment**	
A	Values of integrity and ethics	Employees must know their authority, duties, and responsibilities both orally and in writing.
B	Commitment to competition	Each employee must perform his duties professionally.
C	Management philosophy and operating style	The vision and mission should be the basis of management commitment and operating style.
D	Organizational structure	Must be documented, every employee must know his duties, authorities & responsibilities.
E	Attention and direction given by the head of the library and the campus hall	The Head of Library must participate in decision making in the overall activities of the Library.

No	Control Components	What To Do
F	How authority and responsibility are divided	The division of authority &; responsibility must be documented.
G	HR policies and procedures	Must be well documented.
2	**Risk Assessment**	
A	Identify risks	The risks that occur such as lost/damaged books are well minimized
B	Analyze risks	Libraries should try to minimize errors that occur
C	Managing risk	Training is carried out by the department concerned and continues to control the system.
3	**Control Activities**	
A	Library organization plan	Every month there should be regular meetings for evaluation and planning.
B	Procedure	Library employees must perform their duties in accordance with existing procedures.
C	Access to activities	Asset handlers are handled professionally
D	Independent checks and reviews	Independent checks and reviews are conducted by the chairman of the foundation and its staff.
E	Process handling	Checking & Authorization is carried out by each section head.
4	**Information and Communication**	
A	Methods and Notes	Some of the data must be stored in the database.
B	Maintain accountability of related assets and debts	This process must be handled properly by the relevant departments.
5	**Monitoring**	
A	Supervise management	In new employees, it is necessary to supervise their performance.
B	Other actions under supervision	The use of CCTV is very helpful to track library activities

RFID technology has become an essential part of every modern library in the digital age. It has the ability to make our work in the library more suitable. Yet every new technology comes at a cost. To rectify this, efforts must be made to develop and implement it. In this thesis, the author gives an estimate for implementing RFID in libraries. It is easy to imagine that, the content of RFID tags will increase in strength and tags will dramatically increase their efficiency, security. The expected results of the application of RFID are as follows:

1. RFID microchips are installed on books and make it easier to record books.
2. The implementation of self-service, thereby reducing the library service staff.
3. Make it easier to take stock in the library.
4. Can serve returns independently.
5. Can count the number of visitors automatically.
6. Reduces the power of librarians.
7. Serve easily, quickly and precisely.
8. Save operational costs, especially employee spending costs.
9. Improve the quality of service to users.
10. Use the internet for free.
11. Easily access library activities through owned Social Media.
12. Make it easier to get information through digital libraries.

The application of RFID in libraries is still relatively new and hence there are many features of the technology that are not understood by the general public. The development of RFID technology continues to produce greater memory capacity. It is hoped that in the future many libraries in Indonesia can apply RFID optimally, so that library staff will be maximized in carrying out work, and in providing services to users. In addition, libraries that have implemented RFID will have more value than and will create a modern library in accordance with the times and the development of science and technology (science and technology).

Conclusion

RFID (Radio Frequency Identification) is a superior new wireless technology and has been applied in the library world to develop library services and performance in terms of identification and security, which is a continuous technological advancement of barcode systems. Although the advantages of unique identification and flexibility of RFID are good news, the technology is still not widely understood or widely applied in library environments. This can be seen from some of the shortcomings arising from the application of RFID in libraries. The costs incurred are quite high to use this technology because in its application, standardization and innovation RFID continues to change.

The application of RFID in libraries is still relatively new and hence there are many features of the technology that are not understood by the general public. The development of RFID technology continues to produce greater memory capacity. It is hoped that in the future many libraries in Indonesia can apply RFID optimally, so that library staff will be maximized in carrying out work, and in providing services to users. In addition, libraries that have implemented RFID will have more value and will create a modern library in accordance with the times and the development of science and technology.

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