Automated Library Information System Using NFC Card and Quick Response Code

I Gede Sujana Eka Putra, Ni Luh Putu Labasariyani

I Gede Sujana Eka Putra, Institute of Business and Technology Indonesia, Bali, Indonesia
Ni Luh Putu Labasariyani, Institute of Business and Technology Indonesia, Bali, Indonesia
Corresponding Author: sujanaekaputra@instiki.ac.id

Abstract: *Rapid technological improvements are advantageous to library management. Using Quick Response Codes and RFID technologies as automatic identifiers in library administration is one example. Inaccurate book availability information, a dearth of services for human resources library management, and no assurances about the safety management of the library's collection are only a few of the problems that libraries are currently facing. This project addresses the problems by creating a library management information system that creates automatic identification through the use of Near Field Communication and QR Code technologies. Each library patron has an NFC card, which is used to save their personal data. A QR Code label with the book code information is also attached to each book in the library. The NFC card is first pressed to record the transaction when a visitor returns or borrows a book. Each borrowed or returned book's QR Code label is then scanned. In the final phase, the application was tested by tapping the reader/writer device's NFC card (RFID). It found that the QR Code label could be read up to 40 centimeters from the device, while the NFC card could read or record data from the device up to 7 cm. Automated identifiers enhance services, provide value to the library, and facilitate more precise transaction management.*
Keywords: *Library, Automatic Identifier, QR Code, NFC Card, Accurately*

I. INTRODUCTION

Library administration benefits from rapid technological advancements. In order to identify an object, radio frequency identification (RFID) technology combines the electromagnetic and electrostatic coupling functions in the radio frequency region of the electromagnetic spectrum(Habibi Muhammad and Satrio Adi 2017). The quick advancement of modern technology necessitates the creation of tools that facilitate transactions, such as smart cards, internet-based online payments, RFID, mobile payments, financial technology, and others.

Libraries are currently dealing with issues like inaccurate book availability information, a lack of human resources services, and a lack of guarantees for the safety of book management in the library. Data can be stored on a media card or read using an NFC reader device. Near Field Communication is the application of radio technology frequency identification (RFID), which uses radio frequencies to transmit data. NFC can be utilized for digital transactions, including speedy data transfers and purchases without requiring credit or debit cards, which need a relatively difficult activation process (Rifqi and Wardhani 2017)(I Gede Sujana Eka Putra and Ni Luh Putu Labasariyani 2024)(Sisodia et al. 2024). There are two types of RFID: active and passive. Active RFID labels can send data over great distances and have a powerful signal. In order to transmit data with short scanning distances and at a cheap cost, passive RFID labels rely on an RFID reader (Djamal 2014) (Motroni, Buffi, and Nepa 2021)(Trebuna et al. 2023).

The study develops a library information system that uses RFID cards and QR Code labels to automatically identify book borrowing and return transactions. While each book has a QR Code sticker with book code information, RFID cards are used to record visitor or library member data. Books can be borrowed or returned by tapping the NFC to see who is borrowing or returning them, and by scanning the QR Code labels to see which books are being borrowed or returned. It is anticipated that the study urgency using RFID technology will make the transaction of borrowing and returning books more realistic, provide more accurate information, enhance services for students and library patrons, and provide value to the library in terms of efficiency and usefulness.

II. RELATED WORK

Several studies have been conducted on the use of RFID for many purposes are detailed as follows: research from (I Gede Sujana Eka Putra, Anthony Lee and Dharmayasa 2021) developed a lecturer attendance information system to record lecturer attendance using radio frequency identification technology by implementing Near Field Communication Card. Application to record lecturer attendance for college class, by tapping NFC card to reader device. The NFC cards to record presence in class is more practical for lecturers better than manually using paper. Study from (Lukman and Angriani 2018) RFID is utilized for unique patient codes, and its implementation in hospital medical record queuing systems aims to cut down on patient wait times during medical record processing during outpatient registration. This special code will automatically show patient data, making patient medical record management more efficient. The design of lecture attendance apps utilizing NFC technology is examined in the study from (Mohandes 2017) in order to facilitate the student attendance process through the use of Android-based NFC. Students only need to touch their identity card to the NFC tag detector for the system to immediately enter their attendance and establish a connection with academic information systems. NFC technology on smartphones can detect the owner identification process on NFC chips. Study from (Hidayanti et al. 2023) to implement library information system using QR Code based on web application. In the library, activities such as visitor registration, book recording, book borrowing, returning transactions, and making reports at the library are still done manually, so it requires more time and effort, and mistakes often occur in finding the required data. The author designed a library management information system using a web-based QR Code to solve this problem so that activities can be carried out more quickly and easily. The Waterfall development method is used to build this web-based information system. The stages that are passed in this method are the Requirement, Design, Coding & Testing, Integration & Testing, and Operation and Maintenance stages. The final result of this design is to produce a library management information system using a web-based QR Code for the SMPN 1 Mandalawangi Library. Study from (Rifqi and Wardhani 2017) examine how near field communication (NFC) technology is used in university teaching and learning activities. Its deployment does not rely on an internet network. In general, the presence of lecturers is documented using manual form sheets or web apps that are accessed on computers in the classroom. However, occasionally, connection issues prevented the use of web applications for attendance. To get around this, an NFC card is used for attendance. The lecturer's attendance information is entered into the academic attendance information system by tapping the card on the NFC reader device. Encrypting the data stored on the NFC card makes it sufficiently safe and prevents unauthorized duplication. Study from (Onibala, Lumenta, and Sugiarso 2015) regarding the use of AT Mega 8535 microcontrollers are used in the design of the radio frequency identification (RFID) attendance system, which reads employee attendance data in the form of an attendance application and stores and generates employee attendance reports. The RFID reader can only read tags that are no more than 4 centimeters away. The time gap between reading the first and second tags is approximately more than two seconds. Study from (Wagino, Rosadi, and Wahyudi 2017) create a library application with RFID (Radio Frequency Identification) smartcards. There are issues with library administration because of the growing collection of literature at the South Kalimantan Province Regional Library and Archives Department, the rising demand for library resources, and the limitations of librarian services. Member registration, literature registration, book borrowing, book return, library free letter issuance, and report creation, comprising member list, book list, book borrowing, book return, and fine receipt reports, are the first steps in the library information system. This library application can reduce data processing mistakes and optimize library services. Study from (Insan and Rizal 2019) relates to the use of RFID technology in completing library visit data, linking an RFID reader based on Arduino with database reading. By employing RFID cards to automate library visits, it is possible to prevent duplicate identification and potentially merge RFID technology with Internet of Things (IoT) practical data storage. Research from (Mohandes 2017) on how to enhance library services using Radio Frequency Identification (RFID) technology. Lack of services and the effectiveness of the library's human resources are the issues that libraries face generally. Self-service is made possible via RFID, which expedites the loan and return circulation process and increases efficiency.

III. METHODOLOGY

A. General System Overview

This study approach uses an RFID-based NFC card to create a library information system. Studying the literature on how NFC cards operate, creating a prototype application and coding to read and store data on and from NFC cards, and researching the library's lending and return policies are the first steps in this research process. An analysis to ascertain the language programming is the following step.The Net C# programming language, due to its ability to be integrated into some electronic gadgets. Analyzing the system interface, database design, and hardware requirements comes next. Analysis and design findings are utilized to create applications, which are subsequently tested on the system to ensure appropriate operation. The creation of publications and reports marks the conclusion of this research. Figure 1 outlines the research's progression.
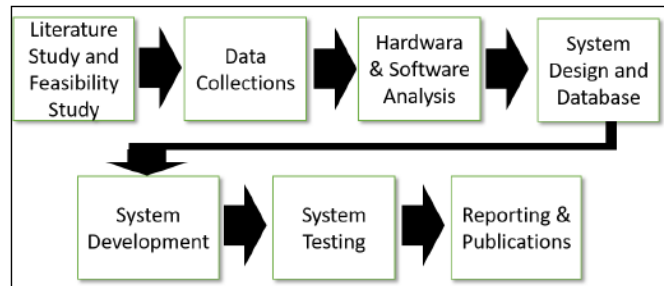
Figure 1 Research Flow

Direct observation and library data analysis are the methods used to collect the data. The design of the system interface is also completed at this point. A library member master, a book master, lending transaction books, and book return transactions make up the system interface design.
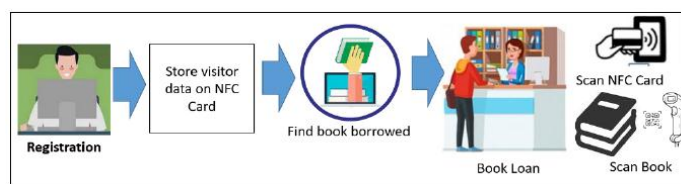

Figure 2. Book Loan Transaction

Figure 2 shows how the book loan process works, beginning with visitor registration and ending with the creation of a new member card using an NFC card. After patrons have entered the library and selected the books they wish to check out, the librarian records the check-out by first scanning the patron's NFC card and then scanning the QR Code label on each book. Library management systems have been used to store information on book loans. The process of returning library books is shown in Figure 3. After a book is returned, the librarian scans the QR Code label on the book and the borrower's or visitor's card. The return date, book ID, and the returned book have all been entered into the system. In addition, the librarian returns the books and reorganizes them on the rack. Book loan and return transaction data can be easily entered into the system, allowing it to automatically summarize the information.
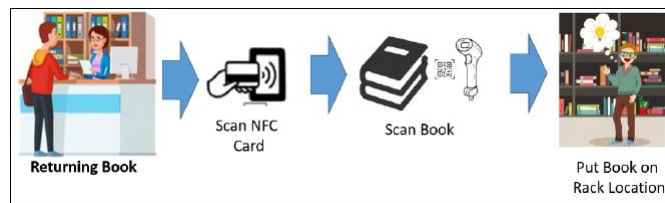
Figure 3. Book Return Transaction
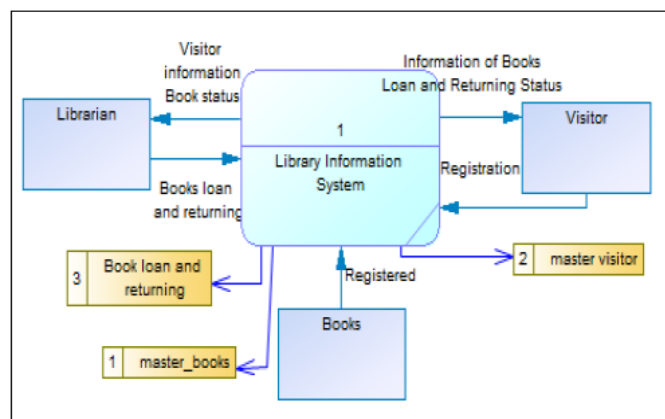
B. Context Diagram Design

Figure 4. Context Diagram

One process node that generalizes the system's overall function in reference to external entities makes up a context diagram. Three external entities, one process, and three data stores make up the context diagram. Visitors, librarians, and books are the entities. Data flow into or out of the system is represented by the arrow, and Figure 4 illustrates each data flow. The information about books is stored in the master books database, the information about visitors is stored in the master visitor database, and the information about book loans and returns is stored in the book loan and returning database.
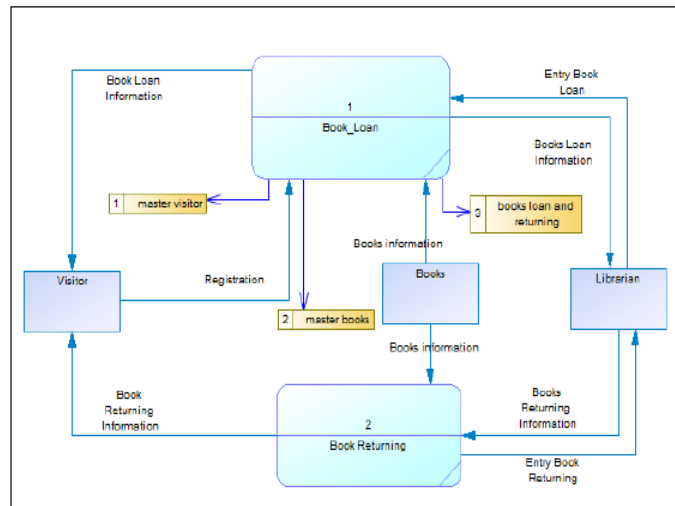
Figure 5. Data Flow Diagram

Figure 5's data flow diagram illustrates how the context diagram is divided into two processes: lending and returning books. Book loan is used to handle all visitor book borrowing transactions, and book return is used to handle all visitor book return transactions, which are managed by the librarian.

IV. RESULT

Referring to the main menu user interface depicted in Figure 6, the Library Information System's main menu comprises the submenus of master visitor, master books, verification module, loan and returning books module, and reporting module.

Figure 6. Main Menu User Interface

The visitor information will be entered into the master data. Figure 7 displays the master visitor user interface.
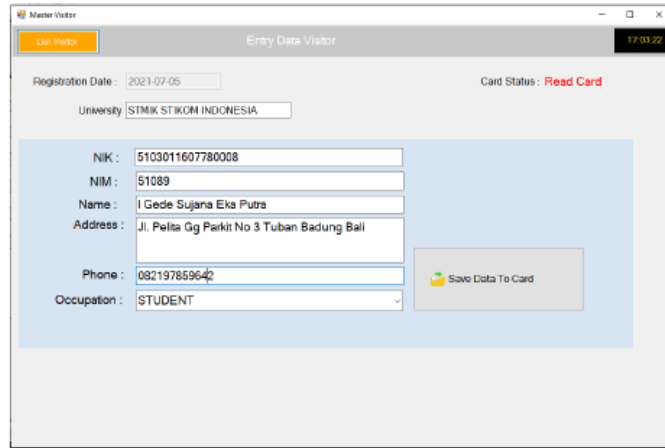
Figure 7. Master Visitor User Interface

After visitor data is recorded using the master data visitor, it is saved in a database and also on an RFID NFC card.
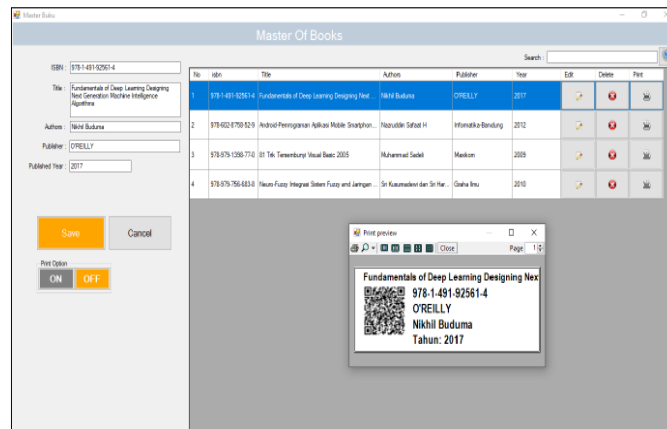

Figure 8. **Master Book User Interface**

The master books module is shown in Figure 8. The application creates a QR code label that represents the book ID and inserts it into each book, while master books are used to store information about books.
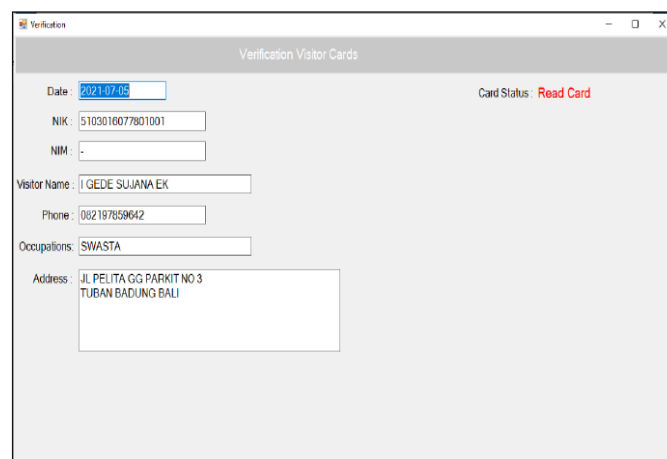

Figure 9. **Verification Visitor Card**

The visitor card verification mechanism is shown in Figure 9. After the visitor data has been saved on the card, this module is used to confirm the visitor's NFC card.
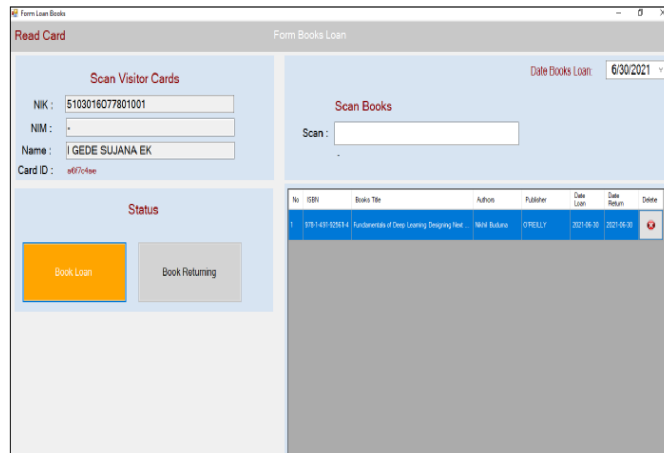
Figure 10. **Book Loan Module**

The book borrowing module is shown in Figure 10. To record book lending, the librarian tapped the NFC Card member into the reader equipment and then scanned the labels of each book. Label scanning makes data recording faster and more feasible.
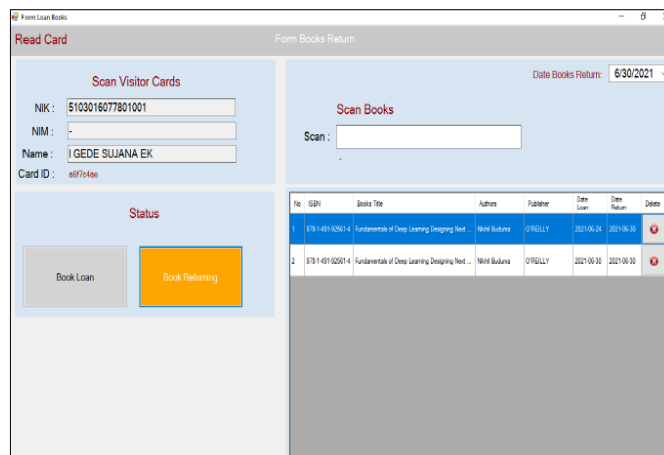

Figure 11. **Book Return Module**

The module used for visitor book returns is depicted in Figure 11. The reporting module, which includes three report options, is used to create reports on loaned and returned books, as seen in Figure 12.
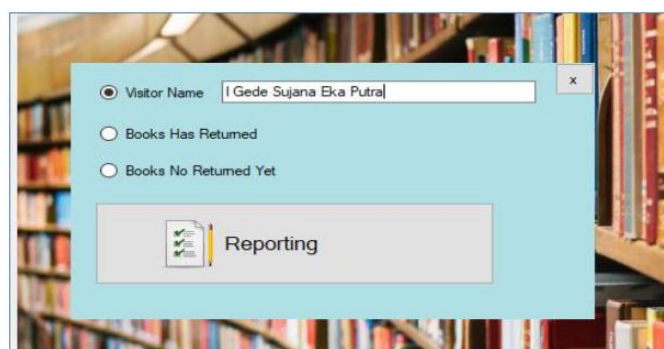
Figure 12. **Report Loan and Returning Book**

An example report summarizing the loan and return of books is shown in Figure 13. The report makes it simple for librarians to reconcile book loan and return transactions by providing summary statistics for both.

Figure 13. **Example Report Recapitulation of Loan and Returning Book**

Figure 14. Example Report Recapitulation of Returning Book

An example report of a recapitulation of book returns is shown in Figure 14. The report provides a summary of all the data pertaining to the return of books.

V. DISCUSSION OF RESULT

According to test results, NFC cards can read and write data from NFC reader devices with a certain level of sensitivity. Table 1 displays the read/write NFC Card into NFC device testing results.

Table 1: Results of the NFC Card-to-NFC Device Tapping Test

Tapping distance (cm)	Position	Can Be Read?	Can Be Write?
0 cm	Stick to NFC device	Yes	Yes
1 cm	Upright	Yes	Yes
2 cm	Upright	Yes	Yes
4 cm	Upright	Yes	Yes
7 cm	Upright	Yes	Yes
8 cm	Upright	No	No
1 cm	Sideway	No	No
7 cm	Sideway	No	No

The NFC Card could be read or written at least 7 cm away from the NFC reader/writer device while it was upright, according to the test findings shown in Table 1. The NFC reader/writer was unable to read or write on the NFC card when it was in the sideways orientation.

Table 2: Results of the QR Code Scanning Test

Label Position	Scanning Distance (cm)	Can Be Read?
Flat	10 cm	Yes
Flat	20 cm	Yes
Flat	40 cm	Yes
Flat	50 cm	No
Folded	10 cm	Yes
Folded	20 cm	Yes
Folded	40 cm	Yes
Folded	50 cm	No
Flat	10 cm	Yes
Flat	20 cm	Yes
Flat	40 cm	Yes

Based on the test results from Table 2, it is evident that a Xenon Honeywell QR Code scanner can read a QR Code label at a maximum distance of 40 cm when the label is folded or in a flat posture. This QR Code can read the folded label position and has a high sensitivity for reading QR Code labels.

VI. CONCLUSIONS

According to the research's findings, the steps involved in developing a library management system include direct observation, literature review, data collection, hardware analysis, database and user interface design, system construction, and testing. The maximum distance at which an NFC card (RFID) could be read or written was 7 cm from the device. However, a QR Code label could be read with a scanner device up to 40 cm away, whether the label was folded or flat. As RFID technology is adopted, the NFC Card may make library management simpler.

REFERENCES

[1]. Djamal, Hidajanto. 2014. "Radio Frequency Identification (RFID) and Its Applications." Tesla 16(1):45–55.
[2]. Habibi Muhammad, Rifki, and Ridi Satrio Adi. 2017. "Design and Build a Car Security System Using ID Cards Using the Radio Frequency
[3]. Identification Method." KOPERTIP : Jurnal Ilmiah Manajemen Informatika Dan Komputer 1(1):39–44. doi: 10.32485/kopertip.v1i1.10.
[4]. Hidayanti, Nur, Ely Nuryani, Raden Kania, and Fergie Yudha Wijaya. 2023. "Design and Development Library Information System Using QR CODE Based on Web Application." Jurnal Sistem Informasi Dan Informatika (Simika) 6(1). doi: 10.47080/simika.v6i1.2417.
[5]. I Gede Sujana Eka Putra, Anthony Lee, I. Made Tirta Mahayana, and I. Gede Agung Wicaksono Dharmayasa. 2021. "Design and Development Of Lecturer Attendance System Using Radio Frequency Identification (RFID)." International Journal of Computer Science Engineering (IJCSE) 10(1):15–27.
[6]. I Gede Sujana Eka Putra, and Ni Luh Putu Labasariyani. 2024. "Medical Records Information System Based on Prototyping Model Using Automatic Identifier NFC Card." World Journal of Advanced Engineering Technology and Sciences 11(1). doi: 10.30574/wjaets.2024.11.1.0315.
[7]. Insan, Rifki Maulana, and Randi Rizal. 2019. "Application of Radio Frequency Identification (RFID) Technology to Library Visit Data." Journal of Informatics And Digital Expert 01(1):1–6.
[8]. Lukman, Musfirah Putri, and Husni Angriani. 2018. "Implementation of RFID Technology in Patient Medical Record Queuing Systems in Hospitals." ILKOM Jurnal Ilmiah 10(1):105–12. doi: 10.33096/ilkom.v10i1.246.105-112.
[9]. Mohandes, Mohamed A. 2017. "Class Attendance Management System Using NFC Mobile Devices." Intelligent Automation and Soft Computing. doi: 10.1080/10798587.2016.1204749.
[10]. Motroni, Andrea, Alice Buffi, and Paolo Nepa. 2021. "A Survey on Indoor Vehicle Localization through RFID Technology." IEEE Access 9. doi: 10.1109/ACCESS.2021.3052316.
[11]. Onibala, Julian, Arie S. .. Lumenta, and Brave A. Sugiarso. 2015. "Design of Radio Frequency Identification (RFID) for ATmega 8535 Microcontroller Based Attendance System." E-Journal Teknik Elektro Dan Komputer 4(7):45–53.
[12]. Rifqi, M., and N. Wardhani. 2017. "Application of the Role and Use of Near Field Communication (NFC) Technology in Teaching and Learning Process Activities in Higher Education." Jurnal Ilmu Teknik Dan Komputer 1(1):20–26.
[13]. Sisodia, Yashanjali, Rupesh Mahajan, Suvarna Alhat, Minal Shahakar, Seema Darekar, and Sarika Sawarkar. 2024. "Classification of ECG For Atrial Fibrillation Using NFC Card for Medicare Record." International Journal of Intelligent Systems and Applications in Engineering 12(16s). doi: 10.1109/TEL-NET.2017.8343567.
[14]. Trebuna, Peter, Matus Matiscsak, Marek Kliment, and Miriam Pekarcikova. 2023. "The Usage of RFID Robots in Logistics Process Management." Acta Logistica 10(1). doi: 10.22306/al.v10i1.359.
[15]. Wagino, Wagino, M. Edya Rosadi, and Arif Wahyudi. 2017. "Library Application Using SmartCard RFID (Radio Frequency Identification)." Technologia: Jurnal Ilmiah 8(1):10–14. doi: 10.31602/tji.v8i1.717.