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Employee attendance information system based on radio frequency identification using prototyping development method

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Abstract

Employee attendance's data shows the presence of each employee in a company that records the time of employee start to work and time for completion work of employee. This data is useful for monitoring employee performance includes working hours, attendance, overtime hours, even for employees who are on duty outside the office. Attendance also has a significant impact on the amount of salary received by employees per month. Companies in Indonesia generally apply manual attendance, using books or manual machines, for example manual attendance machines. This method is inefficient because it requires many forms and is time-consuming. In addition, there are types of electronic attendance, using machines such as fingerprint attendance machines. This method is better than manual attendance methods, but sometimes there are obstacles, namely the machine is less sensitive in reading fingerprints, for example, fingers in a wet/dirty or injured condition. so that finally attendance is done by manual recording. Based on the description above, the author proposes research to develop an employee attendance information system using Radio Frequency Identifier using Near Field Communication (NFC) cards. The use of NFC cards for employee attendance by tapping the card on the NFC Reader device. The use of this technology is quite practical because the sensitivity of the device is good and can read cards accurately. While the software development model uses a prototyping development model that can be adjusted to user needs. The research method begins with a literature study on NFC cards, observing employee attendance methods in the company, designing a database design, building a system that is compatible with NFC readers and writers and user interface displays and conducting system trials. Testing the system by reading and writing data on the NFC card on the card reader/writer unit, the test results showed that the maximum reading distance for the NFC card was 7 cm with a reading angle relative to the NFC reader/writer with 300 can read the NFC card.

Keywords: Radio Frequency Identification; Attendance; Employee; Prototyping

1. Introduction

Employee attendance is data that shows the presence of each employee in a company that records the time of employee arrival at the office but also when the employee wants to go home or finishes work hours[1].This data is needed to monitor employee working hours, attendance, overtime hours, even for employees who are on duty outside the office[2].

In general, employee attendance as a record of attendance to record the hours of attendance and completion of work for each employee. Attendance also has a significant impact on the amount of salary received by employees per month. Companies in Indonesia generally implement several types of employee attendance, namely manual attendance formats, using books or manual attendance machines. This method is inefficient because it requires many forms and is time-consuming. In addition, there are types of electronic attendance, using machines such as fingerprint attendance

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machines[3]. This method is better than manual attendance methods, but sometimes there are obstacles, namely the machine is less sensitive in reading fingerprints, for example, fingers are wet/dirty or injured so that manual attendance recording is carried out[4].

RFID is a method or technology of radio wave-based identification that is able to identify objects without the need for direct contact[5]. RFID consists of an RFID reader (interrogator) that functions as a tag reader, and an RFID tag (transponder) that functions to store data that will later be read by the RFID reader [6]. There are passive RFID tags that have close-range reading specifications, are relatively smaller in size, and tend to be cheaper[7]. RFID is used to describe a system that is able to transmit an object's identity data wirelessly using radio waves[8]. RFID is included in Automatic Identification (Auto-ID) technology. Currently, this automatic identification system is very popular in various industries such as services, purchasing, manufacturing and so on[9]. The use of this technology is quite practical because the sensitivity of the device is good and can read cards accurately.

Based on the description above, the formulation of the problem being studied is how to build an employee attendance information system using Radio Frequency Identifier using Near Field Communication (NFC) cards. The urgency of the research is related to employee attendance as important data for the company to monitor employee working hours, determine the amount of employee allowances or salaries and measure employee performance.

This research proposes the development of an attendance information system using a radio frequency identifier, every employee has an NFC card, which they can tap into a reading device after completing their attendance.

2. Literature Review

2.1. State of The Art

Several previous studies related to the research conducted are as follows: research from [4] developed a lecturer attendance information system to record lecturer attendance using radio frequency identification technology by implementing a near-field communication card (NFC Card). Application to record and read lecturer attendance data during lectures, by tapping the NFC Mi-fare card to the NFC reader/writer. The implementation of the NFC card is more practical for lecturers in taking lecture attendance and the NFC card can be scanned at a maximum distance of up to 7 cm with a card reading angle to the reader device with a range of 0^0 to 30^0. Previous research from [10] implemented RFID in the patient medical record queue system in the hospital, aiming to reduce patient queue time when processing medical records for outpatient registration at the hospital, RFID is used for unique patient codes. The unique code will display patient data automatically so that it does not require patient file search time which can increase patient queue time. Other research from [11] examined the design of a lecture attendance application using NFC technology, an effort to facilitate the student attendance process, carried out by utilizing NFC (Near Field Communication) technology based on Android). NFC technology on smartphones can detect NFC chips on cards for the card owner identification process. Students simply touch their identity cards to the NFC tag detector and the system will automatically input attendance connected to SIMAK. Other research from [7] on the design of radio frequency identification (RFID) for an ATmega 8535 microcontroller-based attendance system to read employee attendance information in the form of an attendance application to store and create employee attendance reports. Tag reading by the RFID reader must be at a maximum distance of <= 4cm which has a tag reading success rate of 100%. The time lag between the first and second tag readings by the RFID reader must be more than 2 seconds for the tag to be read. Research from [10] developed a library application using RFID (Radio Frequency Identification) smartcards. The increasing or increasing collection of library materials at the Regional Library and Archives Agency of South Kalimantan Province, the need for library material information increases, the limited number of library service officers as a problem in library management. The library information system starts from member data collection, book data collection, book borrowing, book returns, providing library free letters and making reports including member data reports, book data reports, book borrowing reports, book return reports and fine receipt reports. This library application can maximize library services and minimize errors in data processing. Another study from [12] examined the web-based attendance system using the agile software development method. This system overcomes the problems in DISPERDAGKOPUMK Kab. Kampar which are still not efficient and effective, starting from data collection, attendance calculations which have an impact on the process of calculating the recapitulation of employee attendance which is relatively long. In addition, the form of attendance reports made in hardcopy can cause errors in data recording, data search processes and there is concern about the loss of employee attendance data. To overcome the above problems, a Web-Based Employee Attendance Information System was created using the Agile Software Development Method which processes data quickly and accurately, as well as taking the amount of data for each employee's attendance according to the development of information needs. Research from [13] conducted research on employee attendance systems with web-based fingerprints. This system is designed to provide an efficient and accurate solution in recording and monitoring employee attendance, with the waterfall

method. This web-based fingerprint attendance information system facilitates access from various devices connected to the internet. This attendance system provides an efficient and integrated solution to monitor employee attendance data so that it is more effective and efficient. The current research is developing an employee attendance system using RFID by implementing a system development method with a prototyping model. This research has a novelty from previous research because with the use of RFID, attendance is done more easily by tapping an NFC card that already contains employee identity to the RFID reader device, saving attendance time, the sensitivity of the tool is very good for reading RFID cards, and employee attendance data can be stored quickly and in real time. And the prototyping development method to describe the system so that the client or system owner has a clear picture of the system that will be built by the development team [14].

2.2. Radio Frequency Identification

Information technology is a means to make it easier to implement automation. Automation systems help in implementing the security and accuracy of stored data. Systems with radio frequency identification provide a sense of security and comfort for users as a means of identifying themselves, for example, shopping centers and others. RFID (radio frequency identification) is a technology that combines the function of electromagnetic or electrostatic coupling in the radio frequency portion of the electromagnetic spectrum, to identify an object. RFID is used as a tool to automatically control a chain of activities. Previous research implemented RFID in a patient medical record queuing system in hospitals, aiming to reduce patient queuing time when processing medical records at outpatient registration in hospitals, where RFID was used for unique patient codes[15]. This unique code will display patient data automatically so that it does not require time to search for patient files which can increase patient queue time [15]. This digital transaction system using RFID is more profitable than conventional transaction systems both in terms of effectiveness and security. The advantage is that you only need one card to access all digital transaction data compared to currently requiring many cards to access it. With one RFID card, it can make it easier for humans to access various digital data transactions[16]. RFID implements electromagnetic sensors that read tags via certain frequencies. Other research related to sensors is implementing motion sensors, temperature sensors, and sound sensors to automatically turn on the lights in the toilet and turn off the lights automatically when there is no one in the toilet. The research carried out was designing a lecturer identity identification system using NFC cards. (near field communication) by storing a little lecturer data into a radio frequency ID (RFID), using an RFID card and an NFC device to read the data on the RFID card[10]. By storing encrypted data on an RFID card, the security of the login system is stronger and cannot be tracked by unauthorized parties logging into the information system. System login is done by tapping the RFID card on the NFC device. If the data matches the previously stored data, then the system matches and displays the lecturer's data accurately[17].

- Active RFID labels require an electricity source in the production process so they are larger, transmit signals to the label reader, and are usually more accurate than passive RFID labels. Active RFID labels have a strong signal so they can be used in hard-to-reach environments such as water, or over long distances to transmit data.
- Passive RFID labels themselves do not use internal electricity and rely on an RFID reader to transmit data. Passive RFID labels are more suitable for use in warehouse environments where interference is rare and the distance is relatively short because passive RFID labels do not use internal resources so passive RFID labels are smaller and cheaper to produce.

The RFID Tag card used in this research uses RFID Mifare 1K, which is a semi-conductor card that works at a frequency of 13.56 MHz on cards and card readers. This card is used for public transportation, parking applications, identity cards, attendance systems, tickets, credit cards, toll cards, and many other applications. RFID (radio frequency identification) is a technology that combines the function of electromagnetic or electrostatic coupling in the radio frequency portion of the electromagnetic spectrum, to identify an object[1]. RFID is used as a tool to automatically control a chain of activities. With the development of information technology that supports business processes, a mechanism for managing large amounts of daily transaction data is needed so that it can be processed quickly. Several transactions implement an automatic system designed to make it easier for users to carry out transactions anytime and anywhere, such as Internet online payments, smart cards, radio frequency identification (RFID), mobile payments, financial technology, and others. In daily life, transactions such as payments still use manual methods using paper money and metal (cash). Now, cashless transactions have begun to be implemented, mechanisms for digitally exchanging transaction information, which can increase the accuracy and security of the transactions. Near Field Communication is the development of Radio Frequency Identification (RFID) technology which is used to communicate data using radio frequency, where the card media can store data or the data can be read using an NFC reader device. NFC is used because of the need for more efficient, accurate, safe, and practical data transmission[18]. Near Field Communication (NFC) technology can be used to carry out transactions, such as exchanging digital content by simply connecting an electronic device to an electronic device that has NFC technology with a touch, users can also buy any ticket just by activating NFC

on their cellphone. NFC has many functions such as being able to transfer data quickly, and making purchase transactions without the need to use a credit or debit card, and is easy to implement because there is no need to go through a complicated activation process[19]. NFC Card can be seen in Figure 1.

Figure 1 NFC Card Mifare 1 K [20]

Near Field Communication is a development of Radio Frequency Identification (RFID) technology which is used to communicate data using radio frequencies, where data can be stored on card media or the data can be read using an NFC reader device[5]. NFC is used because of the need for more efficient, accurate, safe, and practical data transmission[20]. NFC can be used for digital transactions such as exchanging digital content by connecting an NFC card with a reading device/reader that uses NFC, and ticket purchasing applications by activating NFC on a cellphone. NFC has many functions such as being able to transfer data quickly and making purchase transactions without the need to use a credit or debit card which does not need to go through a complicated activation process [7]. RFID consists of active and passive RFID. Active RFID labels have strong signals and can transmit data over long distances. Passive RFID labels rely on RFID readers to transmit data over short scanning distances, and their production costs are cheaper[21].

3. Material and Method

The research method is a research stage that must be determined before research to be carried out clearly and systematically to achieve research objectives.

3.1. The Research Stages

The flow of this research begins with conducting literature studies and literature related to how NFC cards work, practicing making programs/coding on how to store data on NFC cards, and how to read data from NFC cards. Apart from that, we studied the process flow of patient registration activities, disease complaints, and selecting a doctor. The next stage is a system analysis which consists of determining the programming language used. It is planned to use the .Net C# programming language because this programming language is very compatible with integration with digital devices and supports libraries and APIs for reading digital tools to be connected to the system. The next stage is to analyze the hardware requirements needed, for example, NFC reader/writer equipment NFC cards, and label printers to print QR Code labels. The NFC card used is a Mifare 1K card because this card is quite cheap and practical. Continue with the design of the hospital registration system database which consists of a database for master data, and a database for registration transaction data recording complaints and selecting doctors. After designing the database, it continued with designing the patient registration system interface. The results of the analysis and design are used as a basis for system development, and in the system development stage, system testing is carried out to find out whether the system can run well, the recorded data is correct and can be scanned properly, also testing the sensitivity of the NFC card when read with NFC. reader. Process flow and research stages can be seen in Figure 2.

Figure 2 Process Flow and Research Stages

The data collection technique was carried out through direct observation and analysis of the flow of library patient registration and data recorded during registration, recording complaints, and selecting a doctor. This flow is used in the analysis and system design stages. System analysis and design are carried out using Context Diagrams and Data Flow

Diagrams (DFD). At this stage, system interface design is also carried out. The system interface design consists of employee's master data, employee's attendance record, attendance report.

3.2. System Design

The business flow of system as seen in Figure 3.

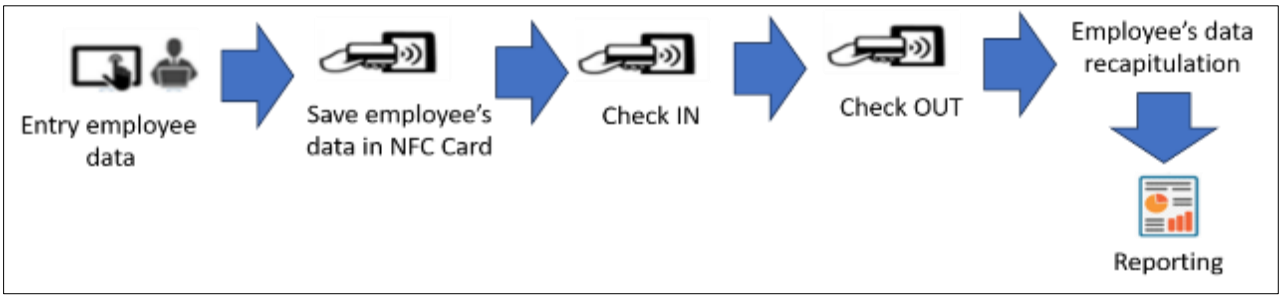

Figure 3 Flow of Employee Attendance System

Figure 3 explains the flow of employee's attendance system. The system overview consists of input entities, process entities and output entities. The input entity contains employees who input their identity data and then record the identity data into an NFC card. When employees come to work, employees take an NFC card and tap the card on the NFC Card Reader machine to read the card for IN attendance and then when they have finished work, employees do OUT attendance. The data recorded in the system is the time of absence from work and absence from work from the employee's identity. This data can be summarized periodically / monthly so that an employee attendance report can be produced.

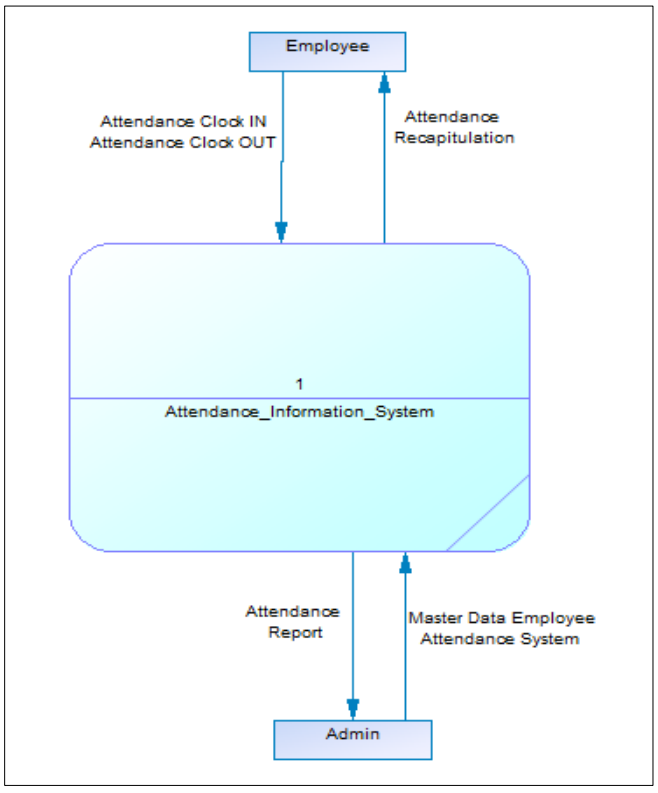

Figure 4 Context Diagram

Figure 4 shows the context diagram of the attendance information system. It consists of 2 external entities they are employee and admin staff.

Figure 5 shows the Data Flow Diagram (DFD) level 1. The DFD level 1 consists of 3 processes, they are registration, attendance process, leave management and recapitulation.

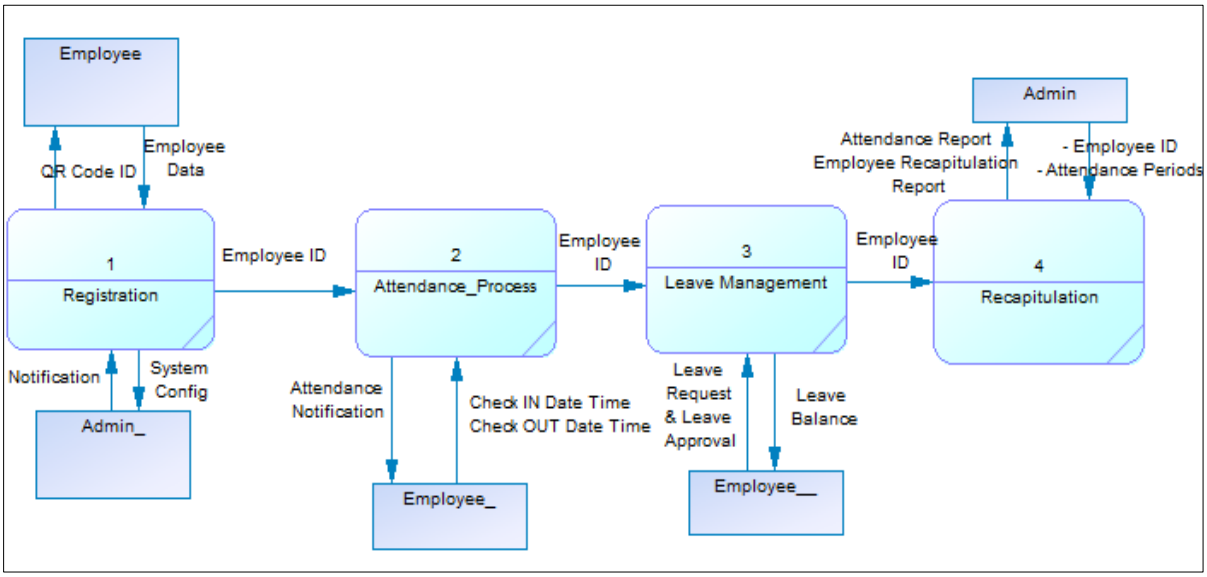

Figure 5 Data Flow Diagram Level 1

The registration process means all the employee enroll their data to create card (NFC) to use for attendance process. Registration includes employee ID, employee name, division, and position. Attendance process is to handle check in and check out during office hours for all employee. Leave management process is to handle leave of employee. All the employee can do leave request, leave approval, Recapitulation process to handle the recapitulation of employee attendance during specific periods.

3.3. Development Model

This information system is built using prototype model system development. This development model is built, tested, and reworked until an acceptable prototype is achieved. It also creates a base to produce the final system or software. It works best in scenarios where the project's requirements are not known in detail. It is an iterative, trial-and-error method that takes place between the developer and the client[22].

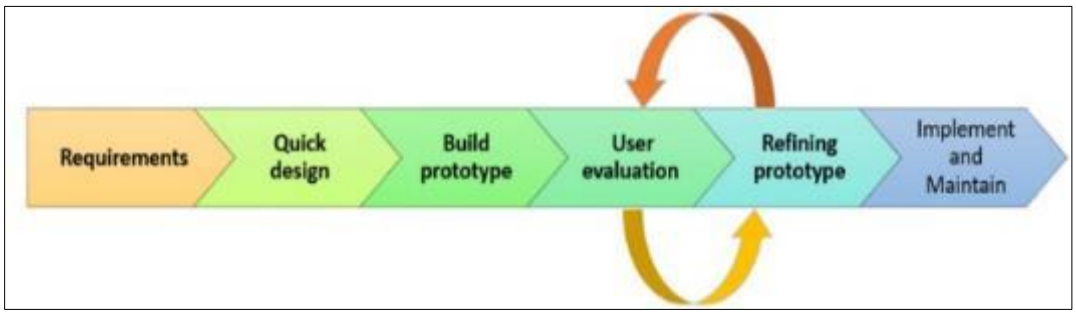

Figure 6 Prototyping Model Phase[22]

Figure 6 shows the prototyping model phase. The prototyping model has 6 system development life cycle phases, they are requirements gathering and analysis, quick design, building a prototype, initial evaluation, refining prototype, implementing product, and maintenance. The prototype was developed under evolutionary prototyping where it was incrementally refined based on customer feedback until it was finally accepted to save time as well as effort.

4. Result and Discussion

4.1. Information System User Interface

The employee attendance system consists of several menus, namely master employee, leave submission, leave approval, input attendance, verification card, attendance report. The display of the employee attendance information system is shown in Figure 7.

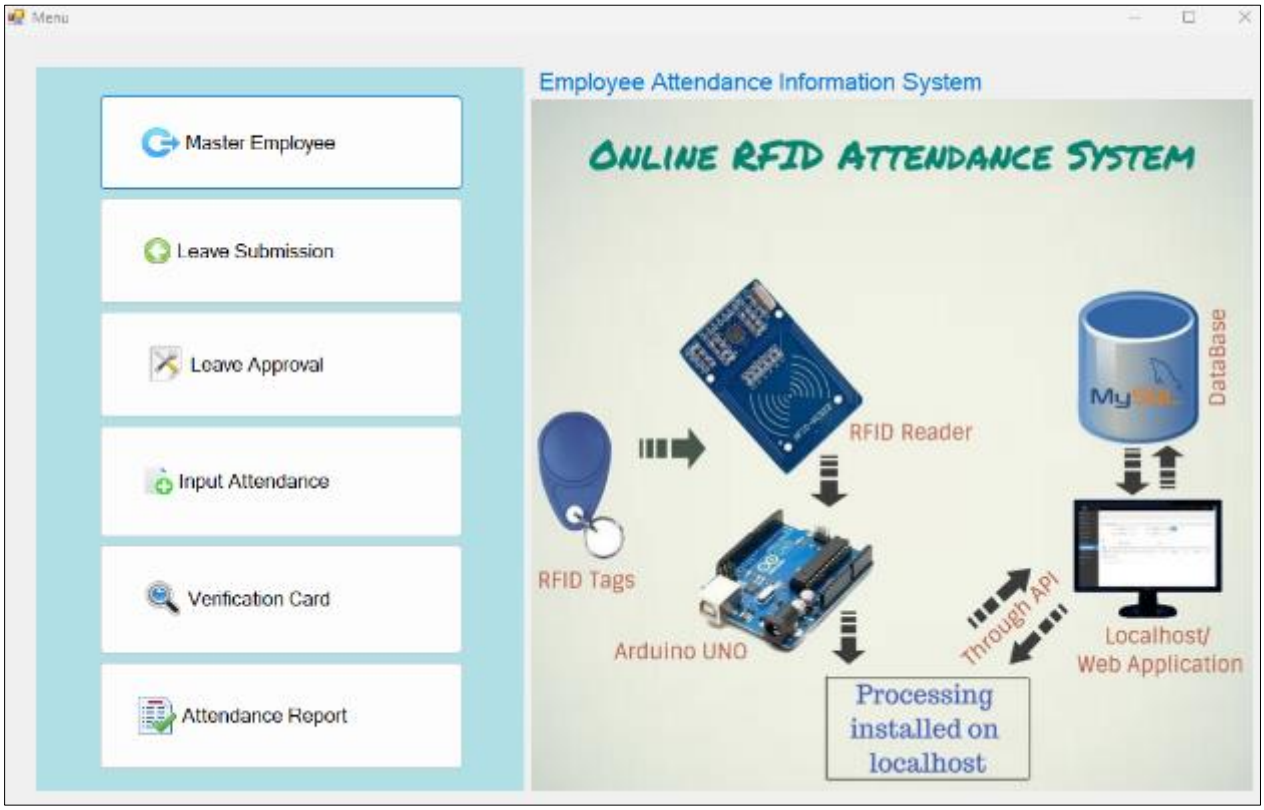

Figure 7 Employee Attendance Information System Menu User Interface

The master employee module is used to register new employee in this application. Employee data need to be input consists of employee ID, employee name, employee division, employee position, date of birth, and employee address. The employee data will then be stored on the NFC Card that is carried by employee when record attendance. The master employee module can be seen in Figure 8.

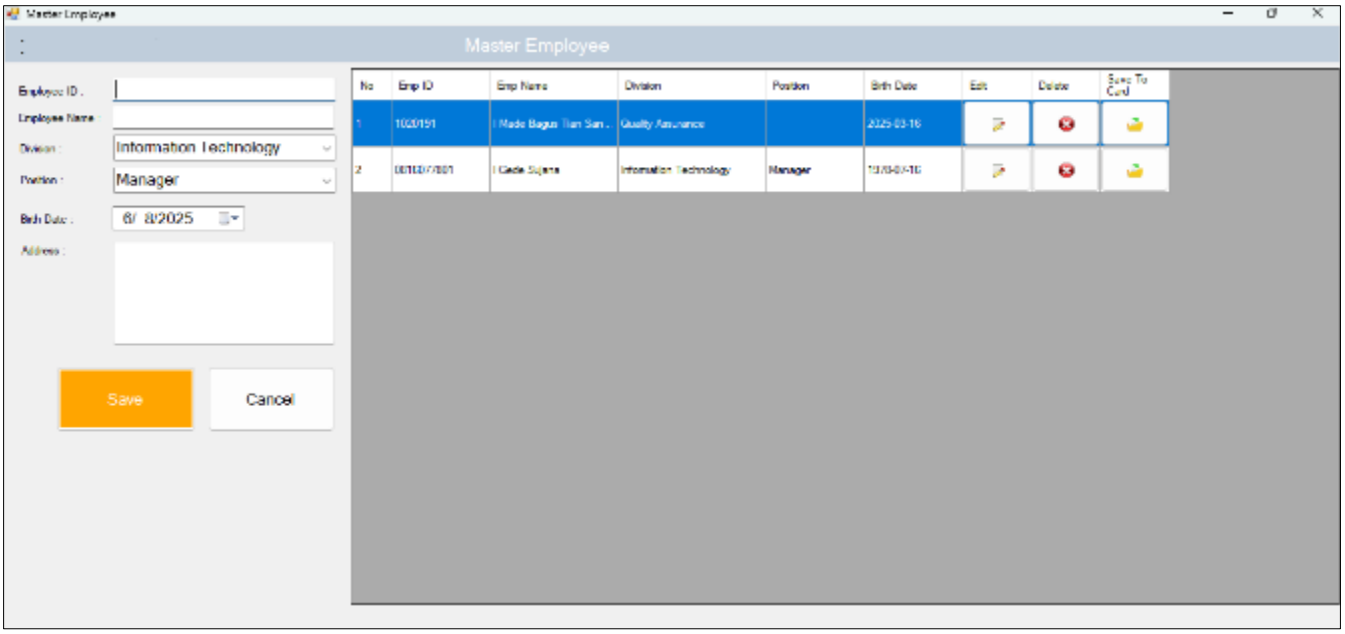

Figure 8 Display of Master Employee Setup

The employee who taken leave also recorded into this application. The employee should input the leave data, they are start date and end date leave, employee ID, type of leave. Type of leave consist of annual leave, time in lieu, maternity leave, wedding leave, religion ceremony, sick leave. Once the leave data has been completed to be input, then it could save and the data shows in the list view of employee leave. The employee leave module can be seen in Figure 9.

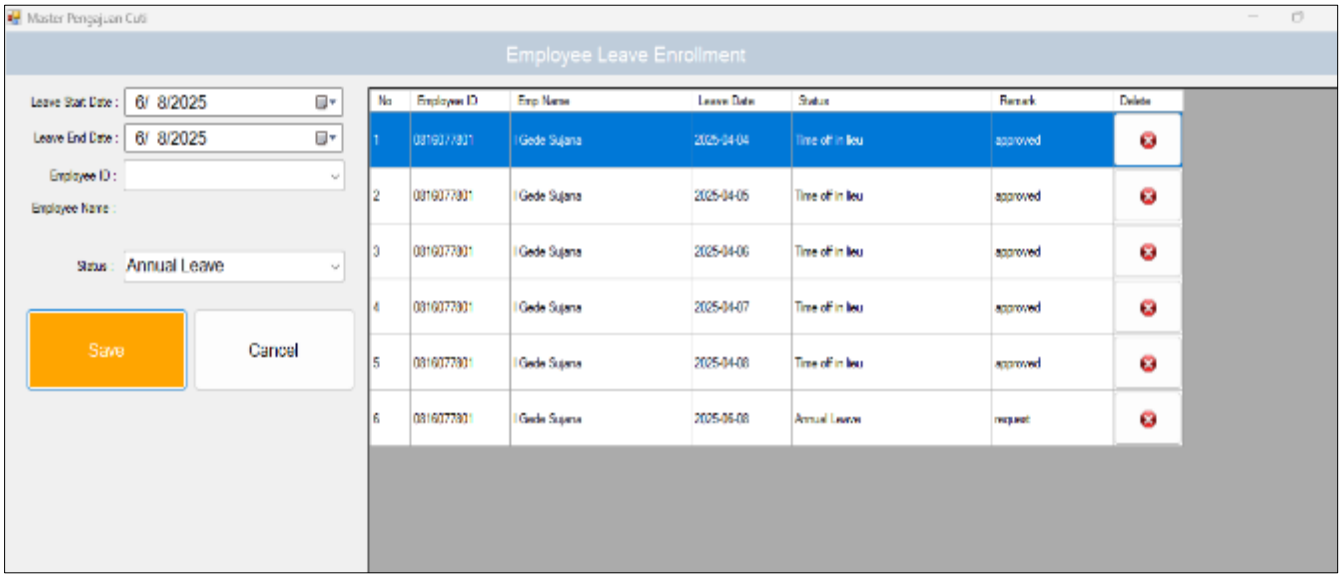

Figure 9 Display of the Employee Leave Module

Once leave has been submitted then the superior considers or not to approve this employee leave submission. To approve the leave submission, the superior just tick the checkbox and then approve the leave request. The leave approval modules are shown in Figure 10.

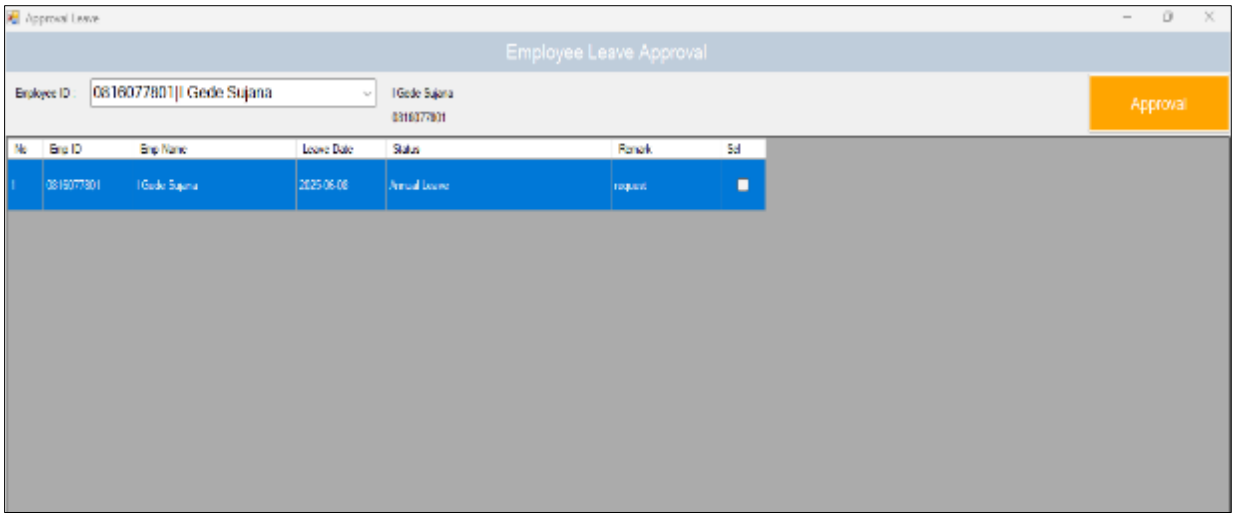

Figure 10 Display of the Employee Approval Module

Figure 10 shows module for employee leave approval. User just select and approve leave request from the list. The Figure 11 shows employee attendance module. Employee tap their card into NFC reader once start to work (time in) and in the end of the day, employee tap again their card into NFC reader. This time in and time out will be recorded into employee attendance system.

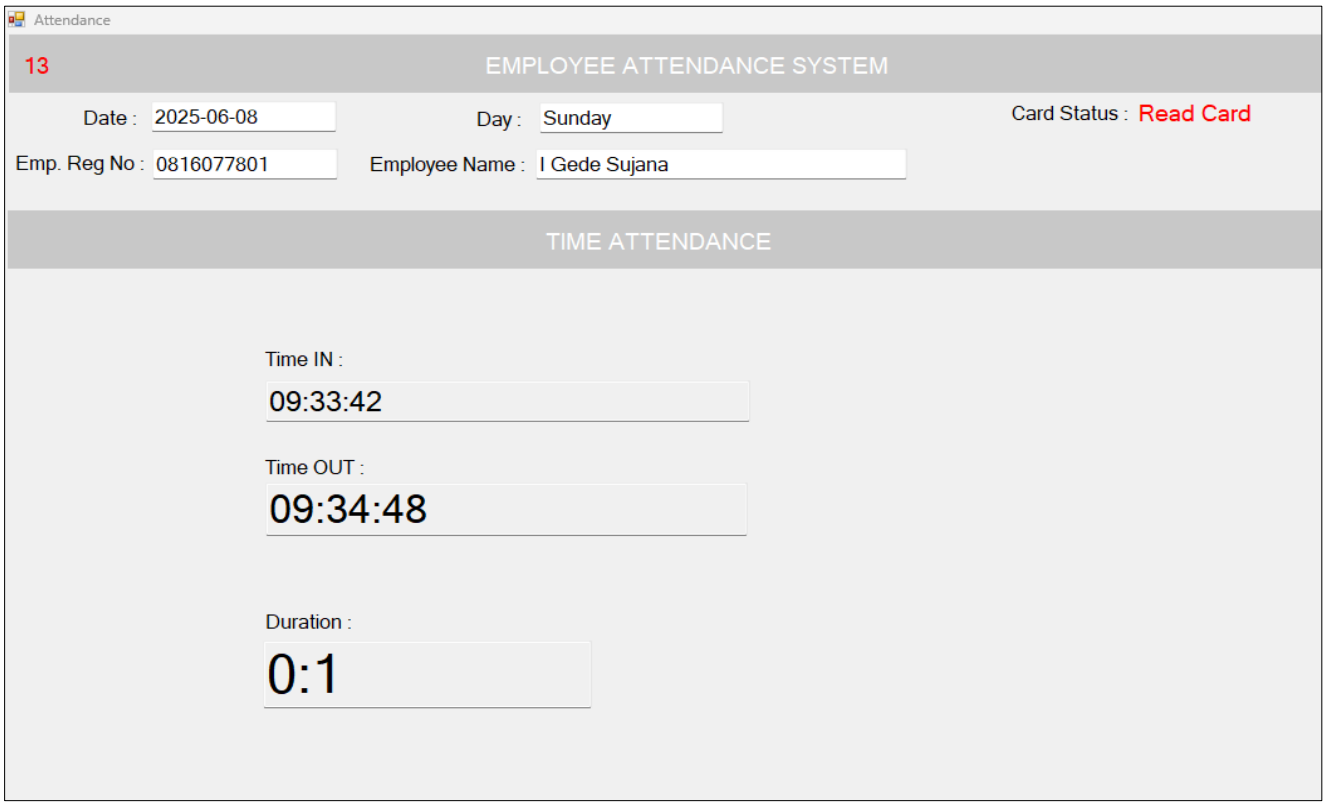

Figure 11 Display of the Employee Attendance System

Figure 12 shows the employee attendance report. This report generated by selected the employee ID and then print out the employee attendance.

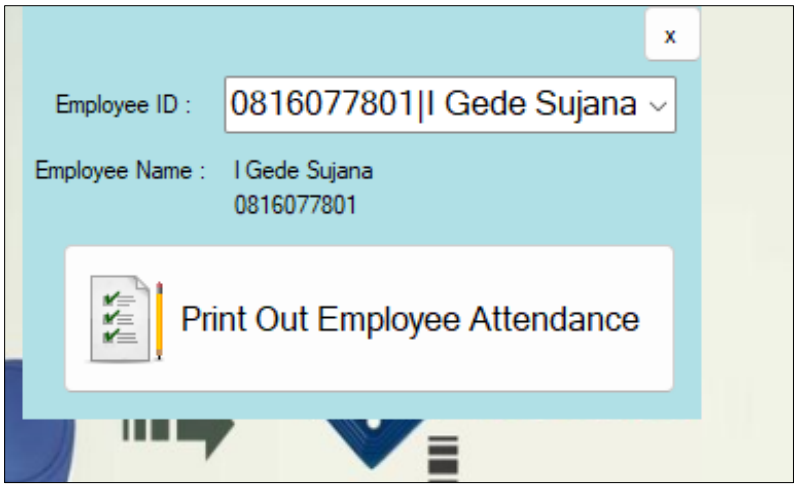

Figure 12 Display of the Patient Medical Record History Module

Figure 13 display the Employee Attendance Recapitulation Report. This report shows the employee's name, division, role / position, time in and time out of employee attendance every day, and attendance status.

EMPLOYEE ATTENDANCE RECAPITULATION

Employee Name : I Gede Sujana **Role :** Manager
Division : Information Technology

No.	Date	Time IN	Time Out	Duration (h:m:s)	Status
1	2025-03-16	03:54:50	04:16:35	00:21:45	PRESENT
2	2025-04-04	01:00:00	01:05:00	00:05:00	LEAVE
3	2025-04-06	01:00:00	01:40:00	00:40:00	LEAVE
4	2025-04-08	01:00:00	01:10:00	00:10:00	LEAVE
5	2025-04-05	01:00:00	01:10:00	00:10:00	LEAVE
6	2025-04-07	01:00:00	02:00:00	01:00:00	LEAVE
7	2025-06-08	09:33:42	09:34:48	00:01:06	PRESENT

Figure 13 Display of Employee Attendance Recapitulation Report

5. Discussion

The conversation covers system testing, which involves examining data stored on NFC cards. The test outcomes indicate that the data is stored correctly on the NFC card. The contents of the NFC card can be confirmed in the verification module. Tests were conducted by bringing the card close to the reading device. Additional tests assessed the sensitivity of reading and writing data on NFC cards with reader devices. NFC cards have a defined maximum distance for reading or writing data with NFC reader/writer devices. The NFC reader/writer can successfully read NFC cards from a maximum distance of 7 cm when positioned upright, but it cannot retrieve data from the side. The results of tests for reading and writing NFC cards with NFC reader/writer devices are summarized in Table 1.

Table 1 Testing Result of Reading NFC Card

Tapping Distance (cm)	Position	Could Be Read?	Could Be Written?
0 cm	Unrestrained	Yes	Yes
1 cm	Oriented perpendicularly	Yes	Yes
2 cm	Oriented perpendicularly	Yes	Yes
3 cm	Oriented perpendicularly	Yes	Yes
4 cm	Oriented perpendicularly	Yes	Yes
5 cm	Oriented perpendicularly	Yes	Yes
6 cm	Oriented perpendicularly	Yes	Yes
7 cm	Oriented perpendicularly	Yes	Yes
8 cm	Oriented perpendicularly	No	No
1 cm	From the side	No	No
7 cm	From the side	No	No

From the test results displayed in Table 1, it is evident that data can be both read and written to the card using an NFC reader/writer device. The maximum range for reading or writing on an NFC tag card is approximately 7 cm, though data cannot be accessed from the side.

6. Conclusion

The stages involved in developing an employee attendance system encompass a literature review, data gathering and observation, database and system design, user interface creation, system development, and system testing, as highlighted by the research findings. Evaluating the reading and writing capabilities of a card on an NFC reader/writer device allows for assessment of the card's effective range. An NFC tag card can be read or written to at a maximum distance of 7 cm. though data cannot be accessed from the side. The use of NFC cards in the employee attendance system improves services for employees and facilitates a more efficient method for recording attendance.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest is to be disclosed.

References

[1] R. Habibi Muhammad and R. Satrio Adi, "Design and Build a Car Security System Using ID Cards Using the Radio Frequency Identification Method," KOPERTIP J. Ilm. Manaj. Inform. dan Komput., vol. 1, no. 1, pp. 39–44, 2017, doi: 10.32485/kopertip.v1i1.10.

[2] I. G. S. Eka Putra, "Design and Development of an E Ticketing Information System for Vehicle Parking Using NFC Cards," J. Teknol. Inf. dan Komput., 2019, doi: 10.36002/jutik.v5i3.799.

[3] K. LakshmiSudha, S. Shinde, T. Thomas, and A. Abdugani, "Barcode based Student Attendance System," Int. J. Comput. Appl., 2015, doi: 10.5120/21036-3147.

[4] I. G. Sujana Eka Putra and N. L. P. Labasariyani, "Design and Development of Login Security System Using Radio Frequency Identification," Log. J. Ranc. Bangun dan Teknol., 2019, doi: 10.31940/logic.v19i1.1301.

[5] J. P. Indonesia, “Improving Library Services Through RFID Technology,” J. Pustak. Indones., vol. 16, no. 2, 2017.

[6] F. E. Christanto and R. Candra, “Card Implementation for Digital Database Transactions,” J. Teknol. Rekayasa, 2017.

[7] I Gede Sujana Eka Putra and Ni Luh Putu Labasariyani, “Automation identifier approach for library management information system,” Glob. J. Eng. Technol. Adv., vol. 12, no. 1, 2022, doi: 10.30574/gjeta.2022.12.1.0115.

[8] I. G. S. Eka Putra, “RANCANG BANGUN SISTEM INFORMASI E TI C KETING PARKIR KENDARAAN MENGGUNAKAN NFC CARD,” J. Teknol. Inf. dan Komput., 2019, doi: 10.36002/jutik.v5i3.799.

[9] M. Rifqi and N. Wardhani, “Application of the Role and Use of Near Field Communication (NFC) Technology in Teaching and Learning Process Activities in Higher Education,” J. Ilmu Tek. dan Komput., vol. 1, no. 1, pp. 20–26, 2017.

[10] I. M. T. M. I Gede Sujana Eka Putra, Anthony Lee and I. G. A. W. Dharmayasa, “Design and Development Of Lecturer Attendance System Using Radio Frequency Identification (RFID),” Int. J. Comput. Sci. Eng., vol. 10, no. 1, pp. 15–27, 2021, [Online]. Available: http://www.ijcse.net/docs/IJCSE21-10-01-010.pdf

[11] M. P. Lukman and H. Angriani, “Implementation of RFID Technology in Patient Medical Record Queuing Systems in Hospitals,” Ilk. J. Ilm., vol. 10, no. 1, pp. 105–112, 2018, doi: 10.33096/ilkom.v10i1.246.105-112.

[12] A. Prasetyo and M. S. Azis, “Design of a Web-Based Medical Record Information System at the Jomin Community Health Center,” J. Interkom J. Publ. Ilm. Bid. Teknol. Inf. dan Komun., vol. 13, no. 2, 2021, doi: 10.35969/interkom.v13i2.47.

[13] F. M. Raihan, “Design of a Medical Record Information System at the Saffira Sentra Medika Clinic, Batam,” J. SNATi, vol. 1, 2021.

[14] M. Olivya, R. Praminasari, D. Jurusan, T. Elektro, P. Negeri, and U. Pandang, “Designing a Lecture Attendance Application Using Near Field Communication Technology,” vol. 2018, pp. 219–224, 2018.

[15] I Gede Sujana Eka Putra and Ni Luh Putu Labasariyani, “Medical records information system based on prototyping model using automatic identifier NFC card,” World J. Adv. Eng. Technol. Sci., vol. 11, no. 1, 2024, doi: 10.30574/wjaets.2024.11.1.0315.

[16] W. Wagino, M. E. Rosadi, and A. Wahyudi, “Library Application Using SmartCard RFID (Radio Frequency Identification),” Technol. J. Ilm., vol. 8, no. 1, pp. 10–14, 2017, doi: 10.31602/tji.v8i1.717.

[17] B. A. Sujatmoko and A. Sujarwo, “Dual Security System for Room Access Control Using RFID at Islamic University of Indonesia (UII),” IOP Conf. Ser. Mater. Sci. Eng., vol. 803, no. 1, 2020, doi: 10.1088/1757-899X/803/1/012029.

[18] R. M. Insan and R. Rizal, “Application of Radio Frequency Identification (RFID) Technology to Library Visit Data,” J. Informatics Digit. Expert, vol. 01, no. 1, pp. 1–6, 2019.

[19] I. G. S. E. Putra, T. Mahayana, and A. Wicaksono, “Library Management Information System Using RFID and QR Code,” Int. J. Softw. Hardw. Res. Eng., 2021, doi: 10.26821/ijshre.9.8.2021.9701.

[20] H. Djamal, “Radio Frequency Identification (RFID) and its Applications,” Tesla, vol. 16, no. 1, pp. 45–55, 2014.

[21] J. Onibala, A. S. . Lumenta, and B. A. Sugiarso, “Design of Radio Frequency Identification (RFID) for ATmega 8535 Microcontroller Based Attendance System,” E-Journal Tek. Elektro dan Komput., vol. 4, no. 7, pp. 45–53, 2015.

[22] Matthew Martin, “Prototype Model in Software Engineering,” guru99, 2023. https://www.guru99.com/software-engineering-prototyping-model.html (accessed Oct. 09, 2023).