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(RESEARCH ARTICLE)

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Development of a smart attendance system using near field communication (SMAT-NFC)

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Abstract

Taking attendance for classes has become more challenging, especially at institutions, due to the growing students population. Typically, the teacher calls names and writes them down. This approach has a number of drawbacks because when recording their attendance, students are diverted from the presentation and may register for absent classmates. The smart attendance solution suggested in this study allows students to tap their student identity (ID) card on a near field communication (NFC) reader, streamlining the attendance procedure by using near field communication (NFC) technology. The technique is affordable, effective, and simple to keep up. Automating student attendance saves time and alleviates anxiety. The average time for the NFC system to take a student's attendance is 3.5 seconds, compared to 16 seconds for the conventional method. The inaccuracy associated with recording attendance is reduced by 31% thanks to NFC technology. The numerical results of the NFC-based scheme are compared with the traditional scheme and observed that the proposed scheme outperforms the conventional scheme.

Keywords: Attendance System; NFC; Reader; RFID; Intelligence

1. Introduction

Attendance is an essential element in every institute, whether it is an educational or working office. But some academic institution is still using the traditional means of taking attendance (i.e., register, paper sheet, or attendance sheet). These methods are not so perfect because they are always time-consuming, and there can be many flaws like cheating in attendance when a friend of one of the absentees marks the fake attendance [1, 2]. By automating the process, the difficulties and challenges associated with the existing attendance registration procedure in a university setting can be minimized, if not entirely removed. This study proposes a desktop-based attendance system that makes use of NFC technology [1].

An attendance system follows a specific individual's attendance and is applied in industries, schools, institutions, or workplaces. The customary way for gauging participation attendance has an apparent downside; Inconsistency in

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information passage and produce blunders, System is entirely reliant upon talented people, Time burning-through, Entry of bogus data, Lack of safety, Duplication of information section, which can be addressed via mechanization using NFC Smart innovation making it more proficient and viable. The near field communication (NFC) as innovation enjoys various benefits [3, 4].

The innovation of NFC set up during the 1980s works dependent on a wireless communication interface that has been around for a long time, the invention of Radio Frequency Identification (RFID), which employments "attractive field enlistment to empower communication between electronic gadgets" . This innovation (RFID) is utilized to move data as radiofrequency to a collector. It is highly perceived, or we can say effective innovation in anything, and for security reasons [3, 4, 5, 6, 7, 8, 9, 10].

Charles Walton was the individual who designed an item utilizing RFID in 1983. After such countless long stretches, Sony and NXP semiconductors presented the new NFC innovation in the 2002 subfield of RFID. In 2004, many organizations consented to make the NFC gathering expecting to refresh the security system and expand the proficiency in the exchange of data [8]. They presented a few norms for generally advantageous and safe utilization of NFC among various gadgets. So that in case somebody makes another gadget, including NFC, it needs to observe the guidelines so it can communicate with other NFC gadgets.

After two years in 2006, numerous gadgets like Smart banners, NFC labels, and savvy labels were concocted, and different organizations likewise enjoyed fusing them. Through the NFC innovation, clients would have the option to send and get recordings or media documents simply by bringing near the two gadgets. In 2006, Nokia's first phone, 6131, was introduced with the NFC chip to interact or be compatible with the NFC tags .Peer applications, which were registered to use NFC technology in 2009, allowed their users to share files with other NFC-enabled phones via Bluetooth or other NFC devices, including other phones. Samsung released the Nexus S, the first Android smartphone to use NFC technology, in 2010.

The following is a summary of the paper's main contributions: First off, the near field communication system is used by the smart-based attendance system established in this study to take attendance quickly, timely, and effectively [4]. Second, the invention and application of the entity-relationship diagram for the NFC-based attendance system for the database management system for the students' records contribute to the novelty of this work. The use of a relational database management system for tracking student attendance is a first for its sort. Additionally, the conventional approach and the suggested NFC scheme are contrasted, and the proposed NFC scheme performs noticeably better than the conventional way, according to the literature [4, 5].

1.1. Literature Review

By taking a friend's test, students can pass off their work as their own. The traditional or manual technique of keeping track of attendance is frequently time-consuming and may interrupt the teaching process. The NFC reader/writer and a tag are the two main components necessary to create an NFC-based system. Conventions for standard correspondence and information exchange that rely on Radio Frequency Identification, or RFID, are covered under NFC. The use of NFC innovation in student attendance systems will likely have an overall impact on the environment for teaching and learning. The idea behind using the NFC-based attendance system is to leverage the two items that students should always have on them (i.e., their matric cards) [6, 7, 8, 9, 10, 11, 12, 13, 14]

This paper surveys past investigations made for an assortment of purposes identified with a modernized attendance system. To accomplish this level-headed, we have a systematic writing audit to recognize all current exploration proof pertinent to this point [11].This examination can add to the assortment of information on the utilization or the reception of NFC in instruction organizations, specifically for overseeing attendance or members in an occasion/class.

1.1.1. Related Computerized Attendance Systems

Barcode Attendance System

The barcode system is a typical type of time and attendance system that can better estimate and track student time. The robotization with barcode innovation eliminates recent manual finance or attendance mistakes. Thus, the system accurately and reliably tracks student attendance. Moreover, the system's setup costs are minimal compared to the cost of financing or attendance errors. The barcode system is easy to use. Each student gets an ID/card with a barcode. The ID/card is traded

on the time clock to enter or exit the grounds. Investigating quantifiable organic characteristics is called biometrics. Biometrics in computer security refers to verification methods that rely on quantifiable real qualities that may be afterwards verified. There are various biometric identification methods, including voice, vein, voice analysis, and hand calculation. When two NFC-capable devices are within 5 cm of one another, NFC communication begins [15, 16, 17, 18, 19, 20, 21, 22]. The director or overseer can download the watch data and use it to update and maintain time and attendance records [22]. In retail, the UPC is a unique 12-digit code that identifies an item and its retailer. The Universal Product Code (UPC) appears adjacent to the barcode of an item (UPC). The UPC for an item is always the same. The first six digits represent the merchant's EIN. The UPCs of all items sold by the merchant will have the same first six digits. The following five digits identify it. The check digit is the last. This is used to verify the UPC for the item. When a UPC is scanned, estimation is made. If the check digit is different from the one determined, the PC knows a significant issue with the UPC. Figure2.1 shows a barcode with its general item code (UPC).

Figure 1 Barcode (source: Wikipedia)

Biometric Attendance System

Biometrics is the investigation of quantifiable organic attributes. In PC security, biometrics alludes to verification strategies that depend on quantifiable actual qualities that can be consequently checked. There are a few sorts of biometric identification plans: retina, hand calculation, vein, voice and so forth [17, 18, 19, 20, 21]. The PC utilizes any of these biometric identification plans to figure out your identity and give your personality approved your remarkable degree of access [18]. Under this system, time and attendance programming with a time clock for representatives utilize biometric innovation for verification purposes. This technique has an extraordinary advantage in that the whole cycle is simple, just as fast. Other benefits incorporate the end of the expense recently caused in getting the student cards [11]. In the other system that utilizes cards (attractive stripe and barcode systems), there is an ongoing cost related to the damage, misplacement and stealing of cards and the constant requirement for their reclamation and card support.

Figure 2 A computerized biometric attendance system (source: the daily chronicle.)

Magnetic Strip Attendance System

Data is encoded in the magnetic stripe of the student card for the magnetic stripe attendance system. The student time clock records the card's magnetic stripe data when it is swiped through the machine. This technology necessitates physical contact with the reader and reads one card at a time as well. A picture of a card with a magnetic strip implanted is shown in Figure 3.

Figure 3 Magnetic stripe card reader with a card (source: Google)

1.1.2. NFC Vs Bluetooth

Similar to how Bluetooth has been operating for years, NFC devices send data packets over radio frequencies to other NFC devices. Why choose NFC instead of Bluetooth? While Bluetooth devices can be much farther apart (depending on the strength of the signal, Bluetooth can be accurate up to dozens of feet away), and Bluetooth devices can transmit much larger packets of data in the megabyte range as opposed to the kilobyte range for NFC, NFC requires very close proximity. But the fundamental distinction between NFC and Bluetooth—and the reason why it only functions close-by—is that NFC devices can be either active or passive, but Bluetooth devices must all be active.

1.1.3. NFC Vs Other Wireless Information Transfer Technologies

Near-field communication is compared to other Wireless Information Transfer Technologies. The goal of the test was to demonstrate the value of NFC. It was one of the most significant discoveries of the 20th century. Modern present registering administrations undoubtedly rely heavily on wireless communication innovations like Zig Bee, Bluetooth, and RFID, as well as Infrared (IR) [13]. A short-range radio frequency convention of communication, NFC operates on 13.56 MHz frequencies, with at least 424 kilobits/sec information transfer rates. The NFC communication starts when the NFC-capable devices are within 5cm. In this assignment, it is claimed that NFC communication is more secure than other methods of communication due to the short transmission time [15].

As shown in Table 1, NFC, Wi-Fi, and Bluetooth work at reduced speeds, with the best information transfer speed. NFC works at 0.4Mbps, slower than Bluetooth and Wi-Fi, and can be used in extreme proximity. According to the designers, we employ NFC because it is short-lived and alluded to as driven individuals. Other benefits of using NFC include speedier delivery when placed within reach and reduced force usage. The designers claim that NFC is superior to other communication techniques.

2. Material and methods

This section discusses the methods and steps that were carried out to achieve the set objectives of this project. These steps will be explained in the following sections.

These sections are Components, Architecture of the Project, Research Process, Development Approach and Design.

2.1. Components

This component can be divided into two major components;

- Hardware component
- Software component

2.1.1. Hardware Components

Below are brief details of the hardware components that will be used in this project;

NFC Tag

The NFC tags are passive gadgets that can be recognized as an actual card, very much like some other card without much of a stretch. Yet, the NFC tag utilizes electromagnetic enlistment for communication. On that card, there will be a tag as displayed in Figure4 underneath. That tag has all the data perused using the Near Field Communication (NFC) innovation [23, 24, 25]. We need to bring that tag near the NFC peruser so that communication can happen. NFC tags have a communication scope of 4-10 cm.

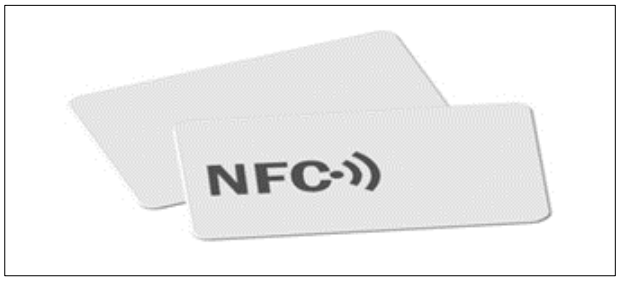


Figure 4 NFC tag

NFC Reader Device

As shown in Figure 5 below, an NFC reader is a device that energizes the passive NFC tag to fetch the information stored in it. NFC readers can be in two forms, one is a separate NFC reader device, and the other is a Smart Phone that featured NFC. For this project, a different NFC reader device is being used.

Figure 5 NFC reader (source: Pinterest)

Laptop

For this project, a PC was used to control all the attendance systems. We will utilize a PC or cell phone for the Application. As they have a working system like Windows and Android, it will be challenging to make an application for the attendance system viable with windows or android. A PC of some ordinary particulars and windows seven or later will turn out impeccably for our undertaking. Furthermore, any sort of new-age cell phone will be helpful in this venture.

2.1.2. Software Components

Below is a brief explanation of the software components that will be used in this project;

Application Software

An application is a product that can be introduced and run on a portable PC: Tablet, cushion, and some other electronic gadgets [7]. The Application is, for the most part, a cell phone term. An application is a bunch of projects or a gathering of projects made for the end clients to control things on PCs or portable.

Database Server

SQL LITE is the database framework employed for this project. It functions similarly to an information stockroom where the site keeps its information and data current. A PC in a LAN that is dedicated to data set archiving and recovery is called a database server. The database worker is in charge of the data sets and the Database Management System (DBMS). It searches the database for specific records as requested by the client computers and sends those records back to the company.

2.2. The architecture of the Project

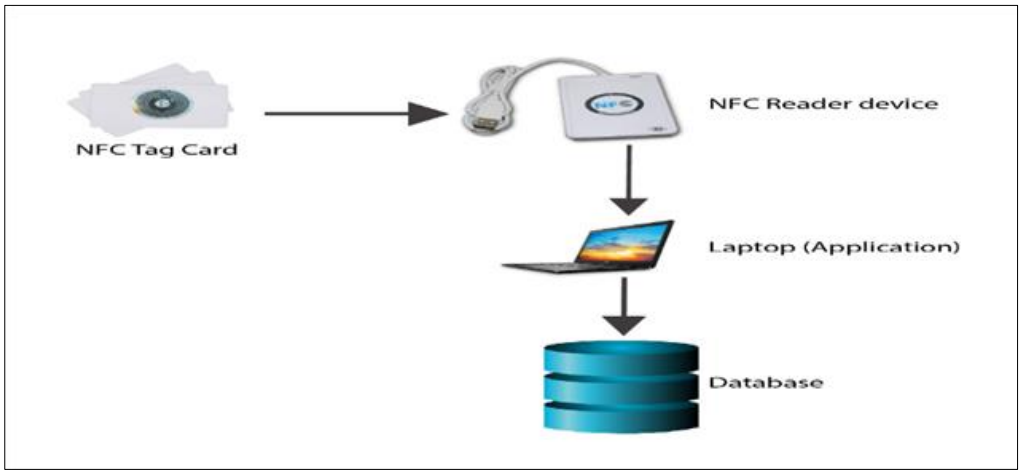


Figure 6 Architecture of an NFC attendance system

This proposed project consists mainly of a web-based attendance system using NFC technology in a desktop device. Figure6 illustrates how the components are going to be connected, which also shows the architecture of the project. From the architectural diagram, the main features of our project are; an NFC tag card, NFC reader device, laptop (Application), and database server [16].

As shown in Figure 6, the first establishment of the process is an NFC tag card that will start the process, and after that, there will be an NFC reader device that will connect with it. After that, the NFC reader device will be connected to the laptop through a USB port to transfer the tag information taken from the student card. After that, there will be a Database at the last stage which is our central part. We aim to move information from the NFC tag card to the Database to store information in it. In between are the peripherals that help us get the data from the non-digital tag to make it digital and computerized and finally stored in the Database.

2.3. Research Processes

Upon completion of this cycle, a model of an NFC-based attendance application will be available; we have chosen to share our strategy into eight stages as it would allow us an opportunity to return and rehash steps taken.

For fostering the application or the product, we need to stream some procedure that comprises a distinct interaction, strategies and steps to follow in like manner. In this project, the water stream programming model will be utilized.

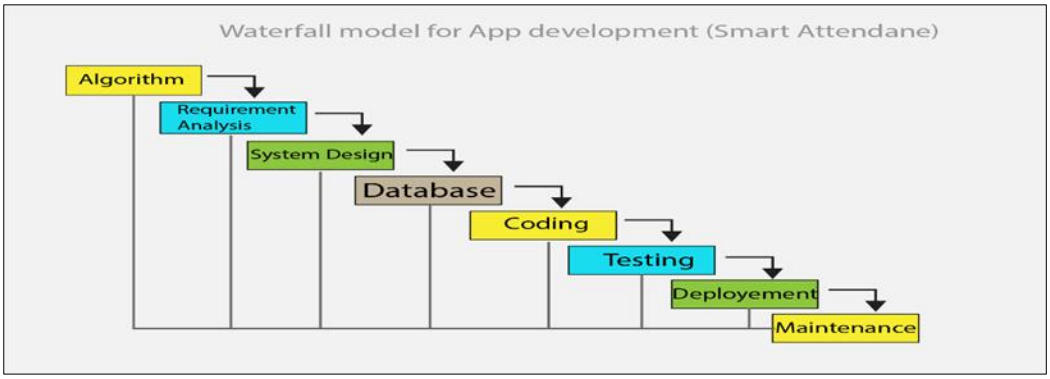


Figure 7 Waterfall software development model (source: Google)

2.4. Development Approach

This project product is a desktop application developed using the Software Development Life Cycle (SDLC). SDLC development life cycle usually consists of the following phases:

- Requirement Analysis
- Design
- Implementation
- Testing
- Evolution

The primary goal of this phase of the SDLC is to make sure that needs are still being addressed and that the system is still operating in accordance with the first phase's specification.

2.5. Design

2.5.1. Data Flow Diagram (DFD)

The data flow diagram is a graphical representation that shows the flow of data in an information system. It offers an overview of the system. For this study, level 0 and level 1 DFD are shown below.

2.5.2. System Interface of NFC Based Attendance System

The interface shows the application interface. The interface is the nearest to human connection. It is additionally called the Graphical User Interface, which is the front-finish of the application that the client utilizes [23].

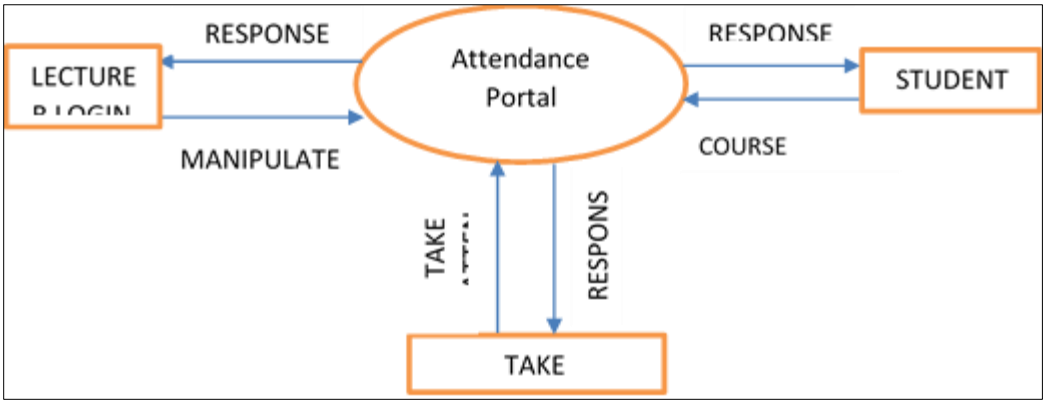


Figure 8 Level 0 DFD of the attendance system

2.5.3. Flowchart

This shows the flow of control in the attendance information system.

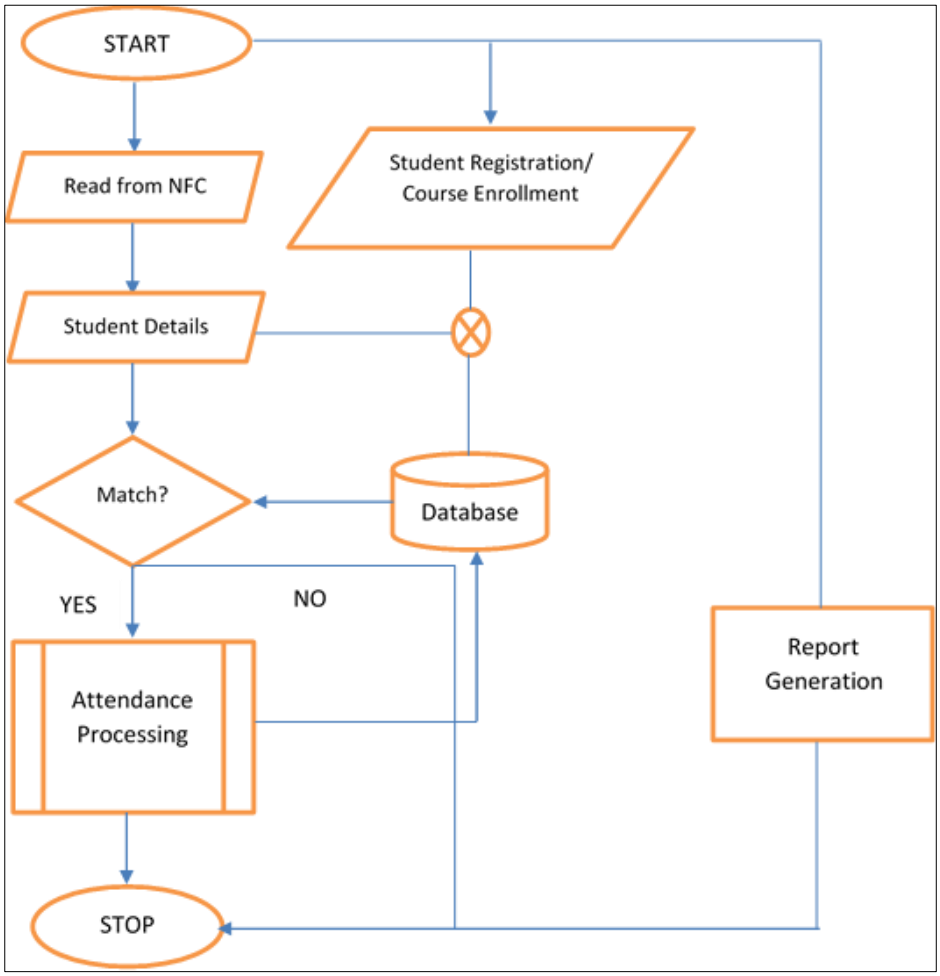


Figure 9 Flowchart of the NFC attendance system

The interface shows the application interface. The interface is the nearest to human connection. It is additionally called the Graphical User Interface (GUI), which is the front-finish of the application that the client utilizes.

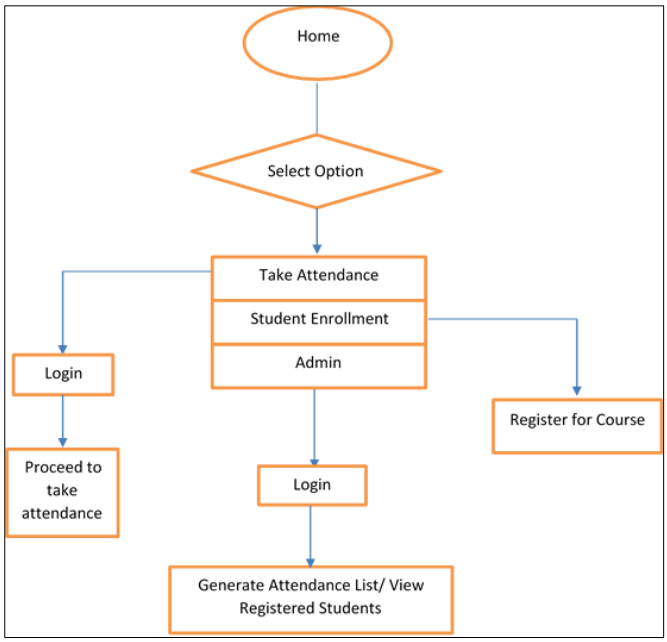


Figure 10 System interface of NFC attendance system

2.5.4. Sequence Diagram

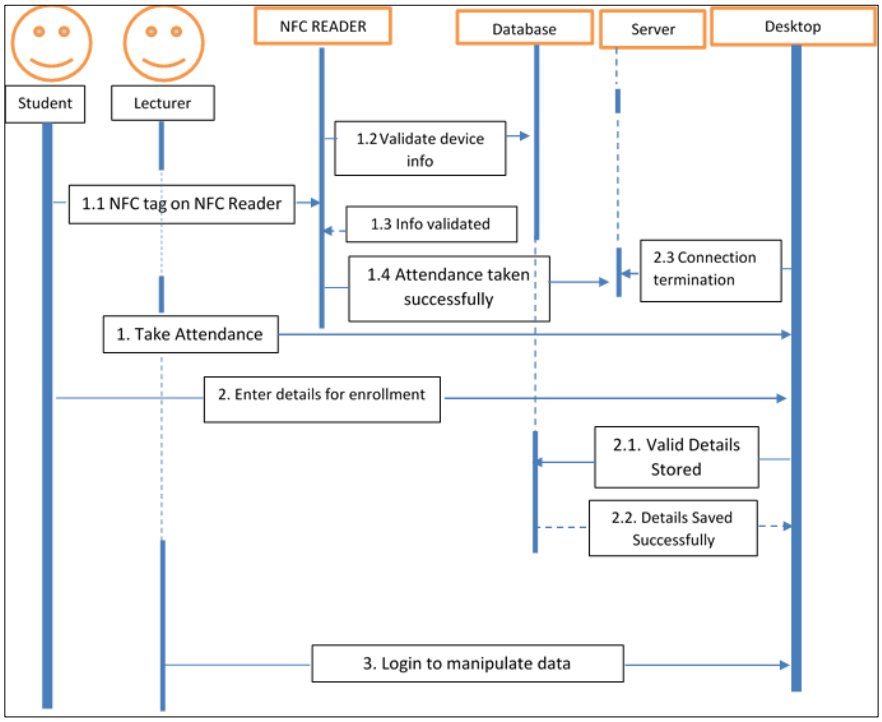


Figure 11 Sequence diagram of the NFC based attendance system

The sequence outline portrays the connection chart that shows how cycles work with one another and in what request. It shows object interactions orchestrated in time succession. They are sometimes called occasion outlines. It centers on the conduct of a few articles in a solitary use case.

2.5.5. Entity-Relationship Model Diagram

An entity-relationship diagram is a modelling language diagram that generates a graphical representation of the entities and the relationships between entities, giving the user a clear understanding of all the entities involved and every action carried out by the system.

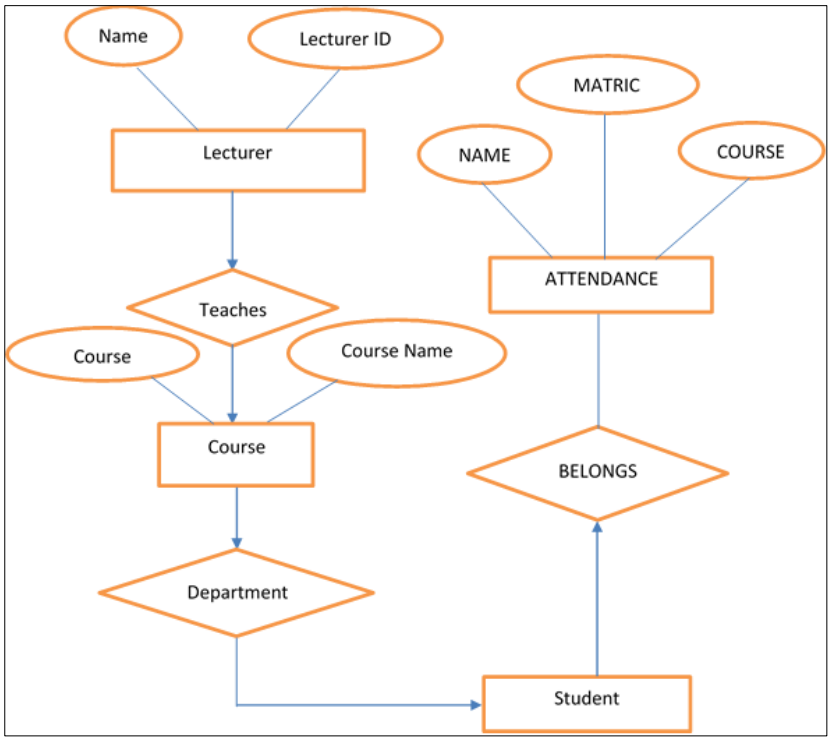


Figure 12 Entity-relationship diagram of the NFC based attendance system

2.5.6. Table Design

A table is a data structure that organizes information into rows and columns. The table can be used to both store and display data in a structured format. Below is the design of the tables of the system.

2.5.7. Tests Carried Out

Accuracy Test

After taking attendance using both methods, to check the error-rate while taking attendance was of importance. We over served the error rate using the traditional means of attendance and using the NFC attendance system.

Cost

This test is very important especially in the engineering field because no matter how very advance your innovations are if they are not cost-effective, they won't be embraced by the masses. For both methods, the cost was based on the devices needed for the attendance system to work.

Lead Time

This test is also very important in the engineering field if an innovative technology is not time efficient it wouldn't matter to the masses and definitely would not help solve human problems but add to them. For the NFC attendance system, the lead time was easily gotten from a desktop application. Each attendance taken had a timestamp of how long it took to register, while for the traditional means of taking attendance, we made use of a stopwatch to determine the lead time.

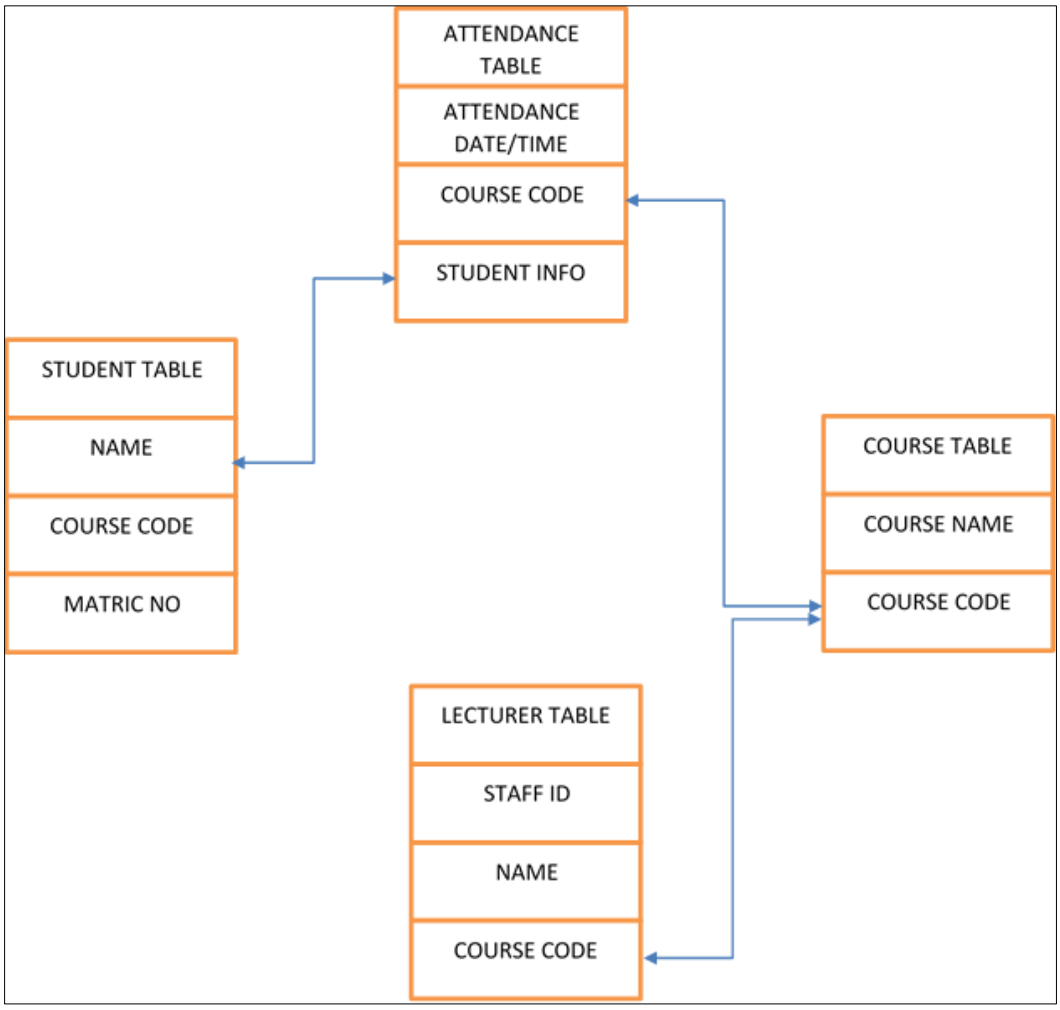


Figure 13 Table design of the NFC based attendance system

Table 1 Comparative analysis of different technologies

	Infrared	**Bluetooth**	**RFID**	**NFC**
Range	Up to 5m	Up to 30m	Up to 3m	Up to 10cm
Speed	115 kbps	721 kbps	424 kbps	424 kbps (1 Mbps soon)
Set-up Time	~ 0.5 sec	~ 6 sec	<0.1m sec	<0.1m sec
Mode	Active-Active	Active-Active	Active-Active	Active-Active Active-Passive
Network Type	Point to Point	Point to Multipoint	Point to Point	Point to Point
Selectivity	Line of Sight	Low	Partly Selective	High
Usability	Data-Centric, Easy	Data-Centric, Medium	Item Centric, Easy	Human-Centric, Easy
Cost	Low	Medium	Affordable	Low

Table 2 Benefits and future direction

	Mode of card emulation.	**Read/Write setting**	**Peer-to-Peer network**
Advantages	• Elimination of physical objects. • Access control via mobile devices; • Consolidation of all daily items in one location.	Makes you more mobile. • Reduces need for physical exertion. • The capacity to adjust to various situations. • Simple to implement	.Simple data transfer between devices. • No pairing of devices. • Enhanced safety
Future Plans	• Storage place for crucial information to protect user privacy and grant people access to that information. Integration of identification cards, passports, fingerprints, and driver's licence.	• An NFC-enabled mobile phone will perform extra tasks in addition to reading some data from an NFC tag. • Advertising agencies have a bright future thanks to decreased space consumption and increased data keeping capability.	• Secure transfer of important data. • Chatting. •Research on psychological consequences is necessary.

3. Results and discussion

This section focuses on the results obtained by using an NFC attendance-based system over the traditional method of taking attendance. It will feature the various observation of the purposed attendance system and the result of the multiple tests carried out.

3.1. Tests Results.

3.1.1. Accuracy Test

This test took attendance using both methods and observed the error rate used to calculate the percentage error. We calculated the percentage error using both ways to determine the overall percentage accuracy.

Table 3 Accuracy test using the traditional method of taking attendance

	WEEK 1					**WEEK 2**					
Student	**MON**	**TUES**	**WED**	**THURS**	**FRI**	**MON**	**TUES**	**WED**	**THURS**	**FRI**	**ERROR**
1	X				X		X		X		4
2		X					X				2
3		X		X		X		X	X		5
4	X			X						X	3
5										X	1
6	X				X					X	3
7		X						X		X	3
8	X		X	X	X		X		X	X	6
9	X	X				X				X	4
10	X	X						X		X	3
TOTAL											34

$$\text{Percentage Error (\%)} = \frac{TE}{TA} \times 100$$

Where;

A = Total Attendance Taken
TE = Total Error

$$\text{Percentage Error (\%)} = \frac{34}{100} \times 100 = 34\% \ (Using\ the\ traditional\ method)$$

Table 4 Accuracy test using the NFC attendance system

	WEEK 1					**WEEK 2**					
Student	**MON**	**TUES**	**WED**	**THURS**	**FRI**	**MON**	**TUES**	**WED**	**THURS**	**FRI**	**ERROR**
1	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	
2	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	
3	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	
4	YES	YES	X	YES	YES	YES	YES	YES	YES	YES	2
5	YES	YES	X	YES	YES	YES	YES	YES	YES	YES	
6	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	
7	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	
8	YES	YES	YES	YES	YES	X	YES	YES	YES	YES	1
9	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	
10	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	
TOTAL											3

$$\text{Percentage Error (\%)} = \frac{3}{100} \times 100 = 3\% \text{ (Using the NFC attendance system)}$$

According to the percentage error calculation of each attendance method, we can see that the NFC-based attendance system's error is far lower than those of the traditional way. Thus, the NFC-based attendance system's percentage accuracy is higher than that of the conventional method. And by calculation and precise observation, one can see that the NFC-based attendance system's percentage error is at worse is 31% less than that of the traditional method.

3.1.2. Cost

Table 5 Cost analysis table

	NFC Attendance System (N)	**Traditional Method (N)**
NFC reader	#10,000	-
NFC Tag	#500	-
Paper	-	2,200 (for 2-months)
Total	#10,500	#13,200 (Annually)

The cost for implementing the NFC attendance system was obtained from the cost of buying the devices needed to implement the system, which in the long run is more economical and reduces the impact of producing paper on forests and cuts energy use. In comparison, the traditional method cost was estimated to purchase paper packs every two months.

The table shows the cost analysis of both methods;

Where;

$$\text{NFC COST} = \text{Cost of implementing the NFC attendance system}$$

$$\text{TM COST} = \text{Traditional Method Cost}$$

$$\text{Percentage cost difference (\%)} = \frac{10{,}500 - 13{,}200}{13{,}200} \times 100 = 20\%$$

From the above percentage cost difference calculation, we can say that the cost of using the NFC attendance system is 20% lesser than the cost of using the traditional attendance system method.

3.1.3. Lead Time

Table 6 Time average for NFC attendance system

Students	**Average measured**			
	WEEK 1 (s)	**WEEK 2 (s)**	**WEEK 3 (s)**	**TOTAL**
1	3.58	3.76	3.74	11.08
2	3.16	3.80	3.82	10.78
3	3.28	3.42	3.43	10.13
4	3.43	3.54	3.25	10.22
5	3.14	3.95	3.42	10.51
6	3.38	3.39	3.94	10.71
7	3.62	3.68	3.77	14.00
8	3.82	3.92	3.98	11.72
9	3.65	3.68	3.67	11
10	3.68	3.36	3.44	10.48
TOTAL				110.63 seconds

The time it took for students' attendance to be taken using the NFC system was obtained by observing students while using the desktop application using a stopwatch, also the time for the traditional method was estimated using a stopwatch. The table below shows the lead time analysis of both methods;

From Table 5 and Table 6, we can see how long each method took to. By calculation, the traditional process took about 540.37secs (0.15 hours; 15mins), which is more time than the NFC attendance system, which took 110.63secs (0.031 hours; 41/2mins). Considering the delivery, this implies that the time it took for the NFC attendance system is less than that of the traditional method.

Table 7 Time average using traditional method

Students	Average measured			
	WEEK 1 (s)	**WEEK 2 (s)**	**WEEK 3 (s)**	**TOTAL**
1	17.44	16.75	18.65	52.84
2	18.13	17.64	16.75	52.52
3	16.92	18.72	19.80	55.44
4	18.56	16.56	17.45	52.57
5	17.94	18.38	17.59	53.91
6	16.68	19.13	17.63	53.44
7	17.73	16.54	18.75	53.02
8	18.49	17.16	18.86	54.51
9	19.21	18.62	18.64	56.47
10	18.64	19.05	17.96	55.65
TOTAL				540.37 seconds

3.2. Regression Analysis and Calculation

Table 7 shows the regression analysis of both methods using the following formulas;

$$\text{Mean Squared Error (MSE)} = \frac{1}{n}\sum_{i=n}^{n}(A_i - F_i)^2$$

$$\text{Root Mean Square Error (RMSE)} = \sqrt{MSE}$$

$$\text{Mean Absolute Deviation (MAD)} = \frac{1}{n}\sum_{i=n}^{n}|A_i - F_i|$$

$$\text{Mean Absolute Percentage Error (MAPE)} = \frac{1}{n}\sum_{n=i}^{n}\left|\frac{A_i - F_i}{A_i}\right| \times 100$$

Table 8 Regression analysis table

Student	**NFC (Ai)**	**TA (Fi)**	$\boldsymbol{A_i - F_i}$	$\boldsymbol{(A_i - F_i)^2}$	$\boldsymbol{\lvert A_i - F_i \rvert}$	$\boldsymbol{\left\lvert\frac{A_i - F_i}{A_i}\right\rvert \times 100}$
1	11.08	52.84	-41.76	1743.90	41.76	3.77
2	10.78	52.52	-41.74	1742.23	41.74	3.87
3	10.13	55.44	-45.31	2053.00	45.31	4.47
4	10.22	52.57	-42.35	1793.52	42.35	4.14
5	10.51	53.91	-43.40	1883.56	43.40	4.13
6	10.71	53.44	-42.73	1825.85	42.73	3.99
7	14.00	53.02	-39.02	1522.56	39.02	2.79

8	11.72	54.51	-42.79	1830.98	42.79	3.65
9	11.00	56.47	-45.47	2067.52	45.47	4.13
10	10.48	55.65	-45.17	2040.32	45.17	4.31
	M = 11.063	M = 54.037		$\frac{(A_i - F_i)^2}{10} = 1850.36$	$\frac{\lvert A_i - F_i \rvert}{10} = 42.97$	3916

From Table 8, we can calculate the Root Mean Square Error (RMSE) as;

$$Root\ Mean\ Square\ Error\ (RMSE) = \sqrt{2040.32} = 45.17$$

Table 9 Regression analysis of NFC

X Values (NFC)	**Y Values (TM)**	$\boldsymbol{X - M_X}$	$\boldsymbol{Y - M_Y}$	$\boldsymbol{(X - M_X)^2}$	$\boldsymbol{(X - M_X)(Y - M_Y)}$
11.08	52.84	0.017	-1.197	0.0003	-0.0203
10.78	52.52	-0.283	-1.517	0.0801	0.4293
10.13	55.44	-0.933	1.403	0.8705	-1.309
10.22	52.57	-0.843	-1.467	0.7106	1.2367
10.51	53.91	-0.553	-0.127	0.3058	0.0702
10.71	53.44	-0.353	-0.597	0.1246	0.2107
14.00	53.02	2.937	-1.017	8.626	-2.9869
11.72	54.51	0.657	0.473	0.4316	0.3108
11.00	56.47	-0.063	2.433	0.004	-0.1533
10.48	55.65	-0.583	1.613	0.3399	-0.9404
M = 11.063	M = 54.037			SS: 11.4934	SP: -3.1522

Calculation Summary

Sum of X = 110.63
Sum of Y = 540.37
Mean X = 11.063
Mean Y = 54.037
Sum of squares (SSX) = 11.4934
Sum of products (SP) = -3.1522
Regression Equation = $\hat{y} = bX + a$

$$b = SP/SSX = -3.15/11.49 = -0.27426$$

$$a = \text{MY} - b\text{MX} = 54.04 - (-0.27*11.06) = 57.07116$$

$$\hat{y} = -0.27426X + 57.07116$$

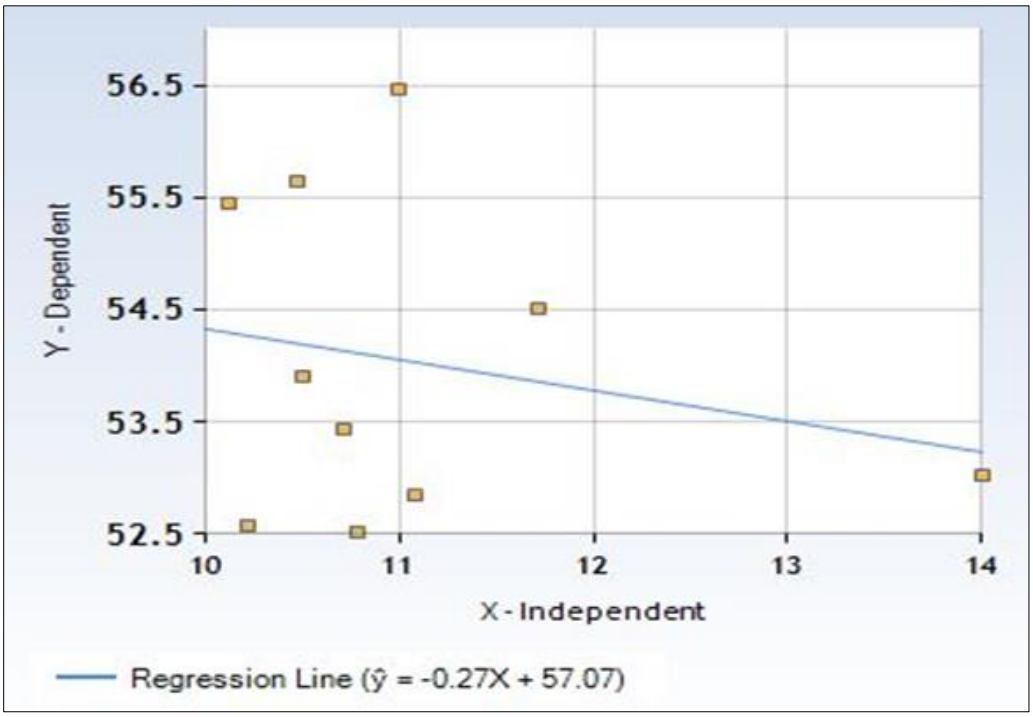
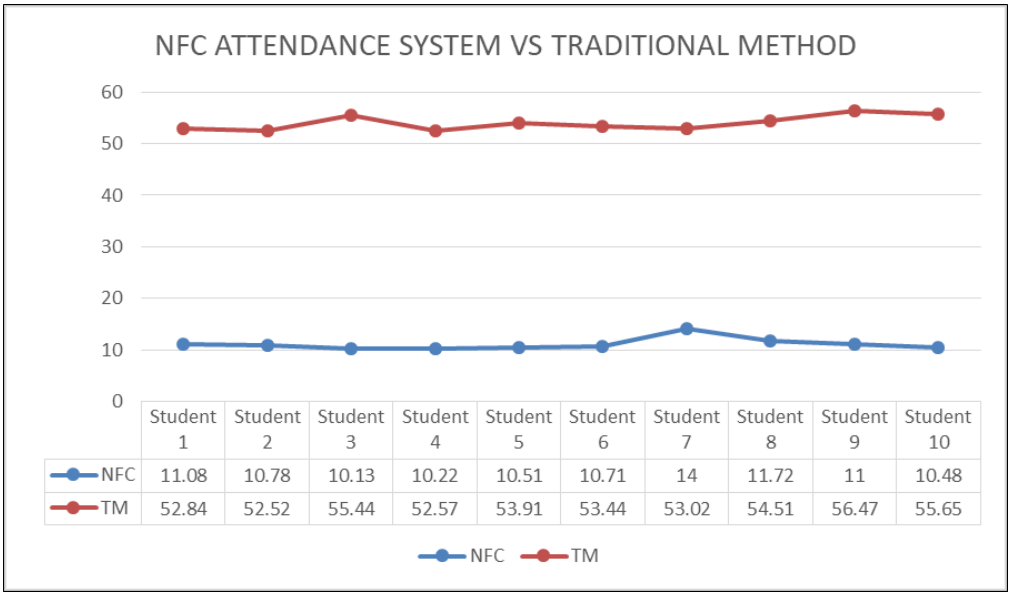


Figure 14 Regression analysis graph



	Student 1	Student 2	Student 3	Student 4	Student 5	Student 6	Student 7	Student 8	Student 9	Student 10
NFC	11.08	10.78	10.13	10.22	10.51	10.71	14	11.72	11	10.48
TM	52.84	52.52	55.44	52.57	53.91	53.44	53.02	54.51	56.47	55.65

Figure 15 Time comparison using the NFC vs traditional method

3.3. Inference

Following the tests carried out, from the results obtained, it is shown that the NFC attendance system is faster, convenient and more economical compared to the traditional method. The tests results show that the conventional process takes an average of 3.5secs to take a student attendance while the conventional way takes an average of 16secs to take a student attendance. It is also shown that the NFC attendance system error rate is 3% while that of the traditional method is 34%.

4. Conclusion

It takes the NFC attendance system an average of 3.5 secs to take a student attendance, while the traditional method takes an average of 16secs to take a student attendance. The system is cost-effective, efficient and easy to operate and maintain. It reduces human labor and the stress involved in taking students' attendance. The machine is readily available and affordable for small- and large-scale applications. NFC is progressively utilized with biometric innovations for security. NFC is a subset of RFID (Radio Frequency Identification). The considerable benefit of a wide range of RFID systems is the non-contact, non-view nature of the innovation. Subsequently, this venture can be beneficial and utilized in real-time use of an attendance checking system, making the traditional method of gauging participation attendance less awkward, time-saving, and effectively reasonable. Attendance at the board in instructive institutions is a vital issue. In many institutions' attendance is essential for an understudy's ongoing evaluation or is a condition that understudies should fulfill before they are permitted to sit for assessments. The system introduced in this undertaking will significantly further develop the current day's attendance enrollment system and wipe out many papers works associated with it. Different advantages incorporate taking out the shot at losing attendance information, distinctive attendance reports can be handily produced with a tick of a mouse, working on the emotional cycle identified with attendance, and so on One of the essential distinctive qualities of the proposed system is that the equipment required is insignificant, (i.e., just NFC tag and NFC-per user). Later on, the NFC attendance system will execute the strategy in an actual establishment set up to approve it.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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