Smart Attendance System

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ABSTRACT

Even though WFH has established a new normal, it still comes with some difficulties that are often overlooked. Whether it be time management, a lack of a work-life balance, social exclusion, technical difficulties, overworking or specific mental health issues, each of these factors has an impact on the workers.There is thus a dire need for the situation in the corporate world to return to normal beyond the comfort of WFH. However, no stringent system along the same lines has ever been put in place. This serves as a major source of inspiration that served as a catalyst for finding a way to encourage a sense of competition among the workers to report back to work. This project offers a great entryway that encourages the employees to go back to the office in order to start working from their respective offices. The project involves real-time logging of each employee's IN time in the google database, followed by biometric or NFC card reader-based authentication. The introduction of an interactive web interface will track the attendance of each employee as well as that of the various departments using streaks.

1 INTRODUCTION

"The COVID-19 pandemic prompted a collective shift to working from home. Although the shift was surprisingly easy, returning to the office will be hard. Firms and organisations are increasingly reporting major challenges persuading employees to come back to the office, driven in part by the surging labour market. We see that more than 70% of UK employees want to work from home 2+ days a week (see Figure 1) with similar figures in the US. " [5]

As organizations grapple with the challenge of bringing employees back to the office in the aftermath of the COVID-19 pandemic, they must confront the fundamental shift in employee preferences and expectations. Surveys indicate that a significant majority of employees express a desire for continued remote work, citing benefits such as flexibility and improved work-life balance. However, organizations must strike a balance that accommodates these preferences while also leveraging the advantages of in-person collaboration and fostering a vibrant company culture. This entails re-imagining office spaces, prioritizing employee well-being, and implementing cutting-edge technologies. By tailoring hybrid work models to individual needs and involving employees in decision-making, organizations can create an enticing office environment that encourages productivity, engagement, and a sense of belonging. Successful navigation of this transition will enable organizations to harness
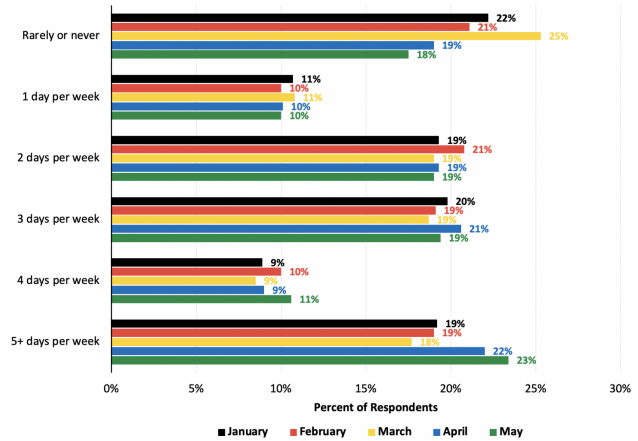

Figure 1: WFH Preferences

the best of both remote and in-person work, shaping a resilient and thriving future of work.

The challenges faced in remote work and the employees' resistance to returning to the office on a regular basis highlight the urgent need to address these issues effectively. While strategies and articles have been proposed on various digital platforms to tackle this challenge, there has been a lack of stringent systems implemented in line with these recommendations. This gap becomes a focal point of investigation, acting as a catalyst to find a solution that instills a sense of competitiveness and motivation among employees to return to the office. To overcome these barriers, a robust attendance system that promotes transparency, fosters collaboration, and provides tangible benefits can play a pivotal role in encouraging employees to embrace the office environment. By implementing an advanced attendance system, organizations can demonstrate their commitment to creating an engaging workplace and foster an environment that motivates employees to transition from remote work and participate actively in the office setting.

2 RELATED WORK

The paper [7] studies the effect of rewards and punishments systems on reducing the employee's tardiness (coming late to work). It says that the quality of service of an organisation is determined by the level of discipline and productivity of the employees. It says that a good employee who arrives on time is more likely to complete
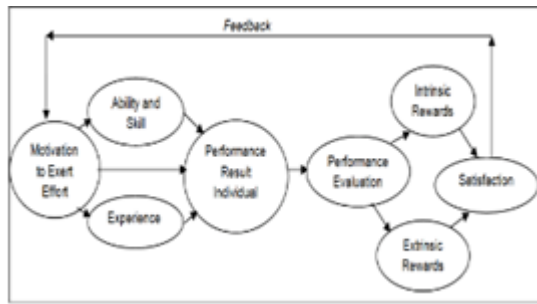
Figure 2: Reward Process

Figure 3: Proposed System

tasks on time, reduced level of delays and increase of efficiency of the organisation. Hence having employees come on time to the organisation will in turn have a positive effect on the quality of service of the organisation. Initially it was found that the organisation had alarming levels of delay in arriving by the employees. In the first stage of the study a punishment system was implemented, and the results were studied. The results showed that the punishment system had no impact on the arrival time of the employees and reduced their motivation to come to work. Different kinds of rewards were awarded to people who were consistent in coming to work on time. This reward system showed to have a huge impact on the arrival time of the employees, in most cases eliminating the late arrival time of the employees. This study showed that having a rewards system motivates people to arrive to work on time. This conclusion helped us in incorporating a rewards system based on employee arrival times to motivate people to come to work on time. While discussing about our project, we were thinking about ways to motivate employees to come to work on time and various methods like punishment systems, rewards systems and feedback systems were initially discussed. Based on the results of the above paper, we implemented a reward system for employees based on their consistency in arriving to work.

Paper [1] introduces an IoT-based bio-metric attendance system for smart classrooms. The system used bio-metric sensors, IoT devices and web technologies to provide a seamless and efficient attendance system. It had interface to allow teachers to view attendance records and generate reports A web interface allows employees to easily view their attendance records and the awards they are eligible for based on their attendance. This can motivate them to improve their attendance record.This paper emphasizes the importance of designing an accurate, efficient, and easy-to-use attendance system. The author's approach of using a fingerprint sensor and Wi-Fi communication for data transfer was used as a reference for the design of such systems.It also discusses the use of fingerprint recognition technology as a reliable and secure means of authentication for attendance systems. In addition, this paper introduces the architecture of the attendance system, including a database server, a web server, and a microcontroller unit that interfaces with the fingerprint sensor and Wi-Fi module. A reward system implemented via a web interface, motivates employees to come to th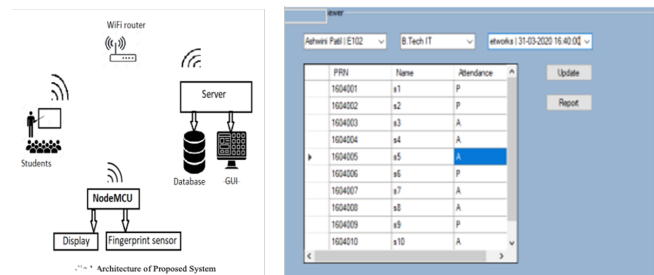e office regularly based on their attendance record. For example, employees with good attendance are given bonuses, certificates, or other incentives. This paper also reports fast response times for attendance acquisition and data transfer, which are essential for designing efficient attendance systems with reward systems. The paper emphasizes the importance of accuracy, efficiency, and ease of use. These are important properties to consider when designing such a system.

Project [2] "IOT based Door lock system" gives a clear idea about linking NodeMCU board (ESP8266) with the Servo motor (SG90). This project aims to provide secure and convenient access control to a user's home or office through a mobile application. This project is very much related to our project in a way of integrating the Servo motor with ESP8266 which of course is interfaced using mobile application in this case whereas we will be using Fingerprint scanner to detect the identity of the employee and automate the Servo motor for opening/closing of the door in our project. The use of servo motor to control the door provides a more user-friendly solution rather than traditional lock system. With Servo, user can simply press a button on their mobile device or use a fingerprint sensor to detect the identity to open/close the door. The problem which is solved through study of this project is interfacing ESP8266 with Servo of course in a very convenient manner using modern approaches like Mobile Application to open/close door with single click. By detecting the user's fingerprint, system provides a secure and convenient way to control access to a door. Moreover, in this project where they have used mobile application to control the servo motor motion, we are controlling the movement not only through fingerprint but also with the help of Ultrasonic sensor (HC-SR04) to detect the user in front of door in addition to fingerprint to open/close the door.

3 USE CASES

The following section presents a detailed discussion on the use cases of the implemented system, demonstrating its practical applications and benefits in real-world scenarios. Let's explore how the system addresses various attendance management challenges and improves overall efficiency within organizations.

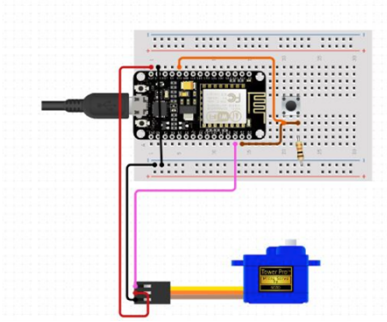- **Use Case 1:** Smrithi doing her 'Employee Registration, Authentication and Time logging.

Figure 4: Hardware Design

Purpose: The purpose of this use case is to register and authenticate Smrithi's identity using either a fingerprint or an NFC card reader and subsequently log her in-time for attendance tracking.

Actor: Smrithi, the employee who needs to authenticate and register herself and have her attendance logged.

Flow of Events: Smrithi approaches the entrance and presents her fingerprint or NFC card to the authentication device. The system will ask the new employee to enter their Name, ID and then the system captures her fingerprint or reads the NFC tag ID from the card. The captured fingerprint or NFC tag ID is mapped against the Smrithi in the system's database once her database is created. The system verifies her identity by comparing the captured data with the registered employee data in the database. If Smrithi's identity is recognized and verified, the system proceeds to log the current time as the in-time for attendance tracking.

Post-conditions: The employee's in-time, along with their corresponding identity, are accurately logged in the system's database for attendance tracking purposes.

- **Use Case 2:** Smrithi uses Web Interface for Attendance Tracking and Streaks

  Purpose: The purpose of this use case is to provide a web interface that tracks Smrithi's attendance, maintains streaks to encourage punctuality, and visualizes attendance data for all employees and departments.

  Actor: Smrithi, the employee who interacts with the web interface to view her attendance and streak information.

  Flow of Events: Marie accesses the web interface using a web browser on their device or Common system. The web interface displays the login page and desired information. Upon successful authentication, the web interface presents Smrithi's personalized dashboard. The dashboard includes a section that displays Marie's attendance streak, indicating the consecutive number of days the employee has been punctual. The interface fetches the attendance data from the database and visualizes it for the current week, showcasing Smrithi's in-time records using pictographs or graphs. Smrithi can navigate to a departmental view to see the attendance streaks of the entire department or team. The

departmental view presents a podium system that highlights the top three employees or departments with the highest streaks, fostering a sense of healthy competition and teamwork. The web interface periodically updates the attendance data and streaks to reflect real-time information, allowing employees to track their progress and make improvements.

Post-conditions: The web interface provides employees with a clear view of their attendance streaks, allowing them to monitor their punctuality and strive to maintain or improve their streaks. The departmental view promotes collaboration and friendly competition by showcasing the top-performing employees or departments. The web interface ensures that the attendance data and streak information are up to date and accurately reflect the employees' actual attendance records.

- **Use Case 3:** Smrithi aiming to get Motivational Features such as Podium, Badges, and Rewards.

  Purpose: The purpose of this use case is to enhance employee motivation and engagement by incorporating motivational features into the web interface, including podium rankings, badges of appreciation, and rewards for achieving milestones.

  Actor: Smrithi, the employee who interacts with the web interface to participate in the motivational features.

  Flow of Events: Smrithi accesses the web interface and navigates to the motivational features section. The web interface displays the podium rankings, showcasing the top three employees with the highest streaks or departments with the best performance. The podium rankings foster a sense of healthy competition and encourage employees to strive for higher positions, promoting teamwork within departments and motivating individual employees. The web interface includes a badge system that rewards employees or departments for achieving specific milestones, such as maintaining a streak for a certain number of days or achieving outstanding performance. When an employee or department achieves a milestone, the web interface awards them a badge of appreciation, visually representing their accomplishment. The badges serve as a visual recognition of an employee's or department's consistency and can be displayed on their profile or dashboard. Additionally, the web interface incorporates a reward system to further incentivize and acknowledge employee engagement. Employees or departments that collect a set number of badges become eligible for rewards, such as gift vouchers or bonus points that can be redeemed for various benefits, such as quick leave approvals. The web interface tracks the progress of employees and departments in collecting badges and rewards, providing a sense of achievement and encouraging continued participation.

  Post-conditions: The podium rankings create a competitive environment and promote teamwork within departments. The badge system recognizes employees or departments for achieving milestones, boosting morale and
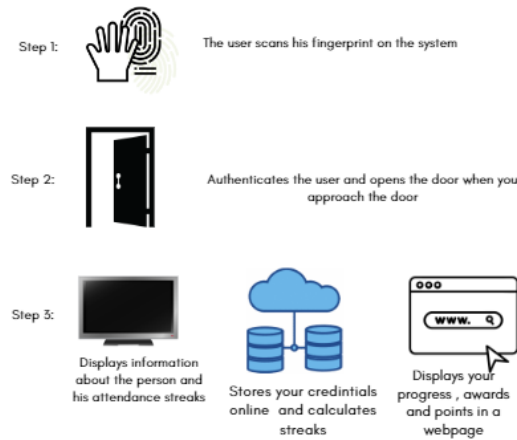
Figure 5: Abstract of steps involved in the project

engagement. The reward system provides additional incentives and benefits to employees or departments who demonstrate consistent performance.

4 IMPLEMENTATION

The main focus of the project was about implementing a smart attendance system where employees of a company could just use their fingerprints to enter the building. Based on this attendance data, attendance streaks could also be displayed in a website in real-time and users can see their streaks and other features of the website. A shot abstract of the steps involved in the project is shown in figure 5 Arduino IDE was used to perform the coding for the project as we found that the flexibility that Arduino IDE provides and its simplicity in connecting to external datasheets and websites and the internet could provide a significant advantage in this setting. ESP8266 was used as the microcontroller to implement the project.

4.1 Hardware Design

ESP8266 was used as the primary microcontroller for the project. Some of the components used in implementing the project are Ultrasonic Sensors, Servo Motor, Fingerprint sensor, OLED, LED, Buzzer and NFC card reader. Servo SG90 Servo motor is used to control the opening/closing of door. OLED (SSD1306 128x64) sensor is used to display user information and the streaks to the employees. Ultrasonic sensor is used to detect how close the user is to the door and automatically open the door. Fingerprint Reader (AS608) is used to read the fingerprints of the users.NFC Card Reader(PN532) is used as an alternate modality in authenticating the user. LED and Buzzer is used to provide visual feedback to the authenticated user. To balance the load involved with the project and also to manage the input-output pins of the microcontroller two ESP8266 Microcontrollers were used and components were divided among the two boards.A schematic diagram explaining the connections is shown in Figure 6 and Figure 7.
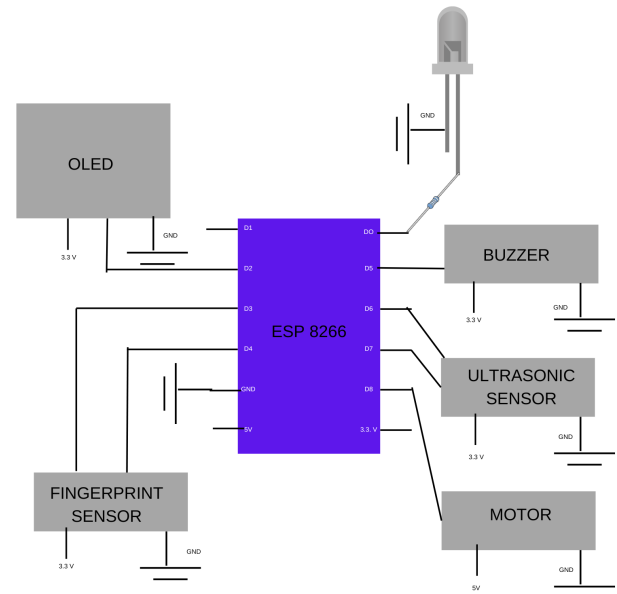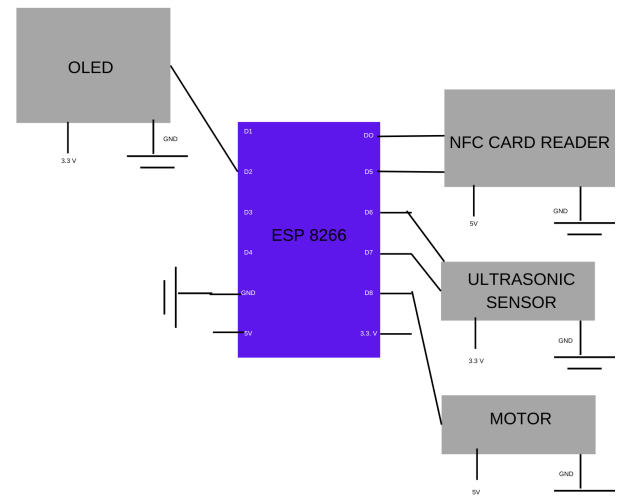

Figure 6: Hardware Design of Controller1

Figure 7: Hardware Design of Controller2

4.2 METHODOLOGY

This section provides insights into the technical considerations, implementation challenges, and use cases of each component in the project. It highlights the careful planning and decision-making involved in ensuring a robust solution. The challenges encountered demonstrate the project's complexity and the innovative problem-solving required. Descriptions of each component offer clarity on

their roles and functionalities. This analysis deepens our understanding of the project's technical intricacies, showcasing expertise and meticulousness in implementation.

Google Sheets Due to its flexibility in editing and also since the number of employees in a company is not a huge database, Google Sheets were used as the database for the project. Google Sheets had good compatibility with ESP8266 and Google Sheets were integrated with the Arduino IDE in a seamless way. App scripts were used to read and write data to sheets. A web app was deployed from Sheets and this id was used to write and get information to the Google Sheets. This id was used to create a scenario on pushing box, which is a website which can collect data from the micro controller and publish it to the Google Sheets.

Fingerprint Sensor The primary part of the implementation was about setting up a Fingerprint scanner system which reads the fingerprints, authenticates them and controls the door. A basic setup to enroll a new user and authenticate an old user was setup. Since one of the requirements of the project was displaying information on a website, the next step in the implementation was to send the name and time of the authenticated user to a database. Initially, it was difficult to automate the process of getting data from the fingerprint sensor, authenticating the user and getting his time data entered on the Google Sheets but the blog ,[4] provided useful insights on automating this process. Based on the methods provided in the blog the process of getting the fingerprint authenticating the user and entering their credentials in real time in the Google Sheet using WIFI was established.

Registering and Authentication: Separate codes for authenticating an old user and registering a new user were written. The aim of the project was to have a system which automatically detects old users and authenticates them, but when encountered with a new user it automatically detects the new user and facilitates to get them enrolled to the fingerprint sensor. Combining old user authentication and user registration was the next challenge in the project. The Arduino codes involved in the separate implementations were analysed and carefully combined to achieve the desired effect. As a result the improved implementation automatically detects a new user and proceed to enroll him to the system, on the other hand just authenticates a old user. **NFC Card Reader** The

NFC Card Reader is an essential component in the implementation of the project. It allows users to authenticate themselves by scanning their NFC cards. The primary focus of the project was on setting up a Fingerprint scanner system for authentication and door control. However, to enhance functionality and not to hinder the process incase of any finger injuries, we have added a second modality of NFC card reader.The card reader communicates with the microcontroller, enabling seamless integration with the existing authentication process. One of the challenges we faced during testing of card reader with the recommended 3.3V supply. However, we had to change to 5v supply to have it properly functioning. Also, we have incorporated the connection of card reader into the second micro-controller and shared the other devices like OLED and buzzer

with the first controller to show authentication feedback.The attendance login details once authenticated with NFC card reader is also sent to the google sheet for creating an online database to update the website in real time.[3] Overall, the incorporation of the NFC Card Reader adds an additional layer of convenience and flexibility to the project.

4.2.1 Authentication feedback. To provide visual feedback to the users that they have been authenticated the following strategies were used.

(1) OLED: When a user has been authenticated, a welcome message along with their Name is displayed on the OLED. In the next step the microcontroller fetches information from the sheets about the attendance streak of the employees and displays it in the OLED. Fetching specific information from Google Sheets and displaying it in the OLED proved to be challenging. The basic idea of getting specific information from Google Sheets and displaying it in the website using WIFI was obtained from [6]. This implementation was studied and a similar implementation was tried to get the employee attendance streaks from Google sheets and display it in OLED.

(2) LED: When the user has been authenticated and a door can open the LED glows indicating the user that the user can walk towards the door and enter the building.

(3) BUZZER: When the user has been authenticated and a door can open the Buzzer sounds indicating the user that the user can walk towards the door and enter the building. Based on the time the user registers his fingerprint the buzzer sounds differently subtly indicating to the user if he is earlier, or has arrived late.

Door control After the fingerprint sensor has authenticated the used and visual feedback is provided, A servo motor is controlled to simulate opening the door. An ultrasonic sensor is used to measure the distance of the user to the door and when an authenticated user approaches the door, based on the readings of the ultrasonic sensor the door opens for the authenticated user. The Servo motor is connected to 5 Volts and hence having many components on the same microprocessor leads to the servo motor getting very less power. To solve this problem a new micro controller was used and a few of the components which consume high power like the NFC reader and the buzzer were migrated to the new micro-controller. After the migration the servo motor functioned properly.

Web Interface The web interface was developed using Streamlit, a user-friendly GUI tool renowned for its quick web interface development and seamless integration with Python libraries. Leveraging the power of Streamlit, we achieved an efficient and intuitive data exploration and visualization experience.

To begin, we extracted employee details, individual streaks, and department-wise cumulative streaks from populated Excel sheets. These data were then parsed and seamlessly integrated into the web interface. Statistical representations, such as bar graphs and pie charts, were generated to visually showcase the log details of the employees, providing valuable insights at a glance.

The heart of our system lies in the reward system, which celebrates exceptional performance. The podium system showcases the top three employees and departments, fostering healthy competition and a sense of achievement. Additionally, deserving employees receive special awards, including distinctions such as the Early Bird for those who consistently arrive well ahead of the login time, the Attendance Ace for outstanding attendance metrics, the Star Streak Accolade for employees with cent-percent attendance in the current month, and the Cohesive Continuity Crown for the department with the best attendance metrics.

To further engage employees, we introduced a claim reward section that enables them to track their collected points. These points can be redeemed for exciting coupons, which are prominently displayed in the leftmost column. By presenting the available coupons, we create a sense of anticipation and motivation, encouraging employees to actively participate in the streak race and strive for continuous attendance excellence.

Overall, the web interface developed using Streamlit provides a cohesive and user-friendly platform for efficient data exploration, visualization, and recognition of outstanding employee performance in terms of attendance.

5 PSEUDO-EVALUATION AND RESULTS

A pseudo-evaluation was conducted to evaluate the performance of the system. The aim of the pseudo-evaluation was to gauge the performance of the project in the following aspects.

(1) Question 1: How effective is the system in providing positive motivation for the employees to arrive on time?
(2) Question 2: How much time does it take for a new user to get enrolled on the Fingerprint system?

People with prior experience working in a company were selected as candidates for the Pseudo evaluation.

5.1 Study Design

The participants were given a brief introduction about the project and the goals of the evaluation. They were then provided with a consent form mentioning the study tasks. In the first step participants of the evaluation are presented with use cases explaining the features of the project. The basic ideas and working are explained to them in a step-by-step manner. They are presented with a list of possible features and statistics available in the web interface. The users are provided with sufficient time to think about the performance of the system and its effectiveness in various scenarios. In the second part participant were provided instructions to be followed to get enrolled using the fingerprint sensor. With the help of the instructions, the participants were then asked to enrol themselves on the fingerprint sensor. The average time takes for a participant to enrol is recorded. After the study tasks the participants were presented with a NASA TLX questionnaire to get feedback about the study tasks.

5.2 Semi structured interview

After the study task and instructions users were provided a questionnaire to receive their feedback. . The questions for the Questionnaire and semi- structured interview are given in the below section.

Questions for the semi structured interview

The Questionnaire begins with a few demographic questions and after this the users were asked to answer the remaining questions below following the format of a semi structured interview.

(1) What gender do you identify as?
(2) What is your age?
(3) Where do you come from?
(4) What is the highest degree or level of education you have completed?
(5) How many years of working experience do you have?
(6) Does the system motivate you to reach the office on time?
(7) Do you feel this system will improve the quality of work?
(8) Do you think people would be more productive if they work regularly in fixed times?
(9) Do you think that system will have demotivating effects in any way?
(10) Do you prefer to add any other features to this system?
(11) How easy was it to enroll yourself using the fingerprint sensor?
(12) Were the instructions provided by the system useful in enrolling to the fingerprint sensor.
(13) Do you think that the process of enrolling is intuitive for first time users

5.3 Results

Based on the answers of the participants for the semi structured interview the following analysis was made. The participants felt that the rewards system would motivate the employees to arrive on time. Most Participants felt that having team statistics would improve teamwork, but some participants felt that having team statistics would increase unrest and blame culture among the team. Participants felt that having everyone arrive at the office at a specific time could increase the productivity of the team. The participants suggested that having an equivalent system to motivate employees to also leave on time can lead to increased work life balance. Some participants wondered about the efficiency of the system in cases of having employees working from home or in cases where employees are on approved vacations. Participants also felt that incorporating NFC card readers can also increase the scope of usability of the system. Based on this feedback at an early stage NFC card readers were also incorporated into the system. The participants also felt that rewards would be effective in motivating employees to arrive on time. Most participants felt that the enrollment system was intuitive and easy to use. While some participants felt that the instructions provided by the system were easy to follow. Some felt that the instruction could be made simpler and more natural

to follow. Based on this feedback the instructions provided by the system were modified, in the updated system the instructions provided to the user was more simple and guided the user at each step of the registration process. The time taken for each user to get registered using the fingerprint sensor is given as a bar graph below. The x-axis is the participants and the y-axis gives the time taken in seconds to get registered to the system.
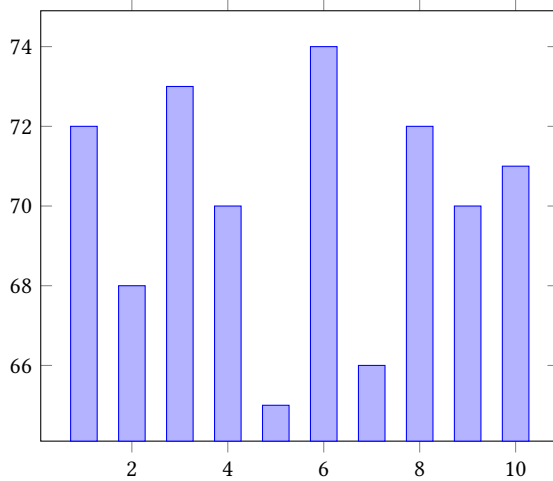
6 CONCLUSION

The COVID-19 pandemic has caused hurdles in getting employees to return to the office on a regular basis after experiencing the benefits of remote work. There is a need to overcome the opposition experienced by firms and devise tactics to bring people back to the office environment. Implementing a robust attendance system becomes crucial in fostering competitiveness and motivating employees to embrace the office setting. By tackling this dilemma, firms can navigate the shifting work landscape while optimizing productivity and cooperation.

The project involves real-time logging of the IN-time of each employee into a Google sheets, followed by bio-metric or NFC card reader-based authentication. An interactive web interface will track attendance of each employee as well as that of the various departments using streaks.To amplify employee enthusiasm for working from the office, the web interface of our system incorporates captivating features designed to foster engagement and promote a sense of achievement. The podium system highlights the top three employees with the longest streaks of attendance, encouraging healthy competition and teamwork. Departments can also be compared based on the total streaks of their employees, fostering collaboration and a collective drive to excel. Additionally, a badge of appreciation is awarded when employees or departments achieve milestones, recognizing their consistent attendance. As a further incentive, rewards such as gift vouchers are presented to employees who collect a set of badges, which are redeemable.

To realise such an implementation, we included the interfacing of ESP8266 micro-controller with fingerprint and NFC card-reader,

which recorder the identity of the individual employees and populated the linked google sheet along with their respective login time. Furthermore, each of the employee is authenticated which further controls the automatic opening and closing of the door via ultrasonic sensors.

Based on a pseudo-evaluation, it is predicted that adding the enticing features to our attendance system's web interface will likely improve attendance metrics and motivate staff to work from the office. A motivating environment is created by the podium system, badge of appreciation, and reward system, which encourages healthy competition, recognition, and concrete incentives. These factors are supposed to encourage workers to keep up their attendance records and contribute actively to the workplace. Although more evaluation and analysis are needed to pinpoint the exact impact, the preliminary analysis indicates that these alluring features will favorably affect employee engagement and attendance.

To improve the attendance system, we suggest implementing several enhancements. Firstly, we recommend extending the data logging to an IoT-based cloud database. This will provide a more secure and scalable solution, allowing access to attendance records in real-time from anywhere. Additionally, we suggest incorporating login credentials for each employee to enhance data privacy and authentication, further strengthening the system's security.

Another valuable improvement would be to expand the reward system to include intra-organizational benefits. For instance, incorporating attendance metrics in performance reviews will highlight the importance of consistent attendance and incentivize employees to prioritize their presence in the office. Moreover, giving faster leave approval as a reward for maintaining a good attendance streak will streamline administrative processes and increase employee satisfaction.

We are proposing improvements to the attendance system that will enhance its functionality and create a more efficient and engaging work environment. These enhancements include improved data management, better security, and a rewards system that connects attendance with performance and organizational benefits. This forward-thinking approach ensures that the attendance system will continue to adapt to the changing needs and expectations of the organization and its employees.

ACKNOWLEDGMENTS

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