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RESEARCH PAPER

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# E-HEALTH ARMBAND REMINDER WITH GPS TRACKER FOR STREET SWEEPER OF CENRO CALAMBA CITY, LAGUNA

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***Abstract:*** This study presents the development of an E-Health Armband Reminder with a GPS tracker designed specifically for Street sweepers of CENRO Calamba City, Laguna. The objective of this project is to enhance the safety and efficiency of street sweeping operations by providing real-time monitoring and reminders to the sweepers. The E-health Armband Reminder incorporates a GPS tracker that allows supervisors to track the location of the sweepers in real-time. This feature enables efficient deployment of resources and facilitates prompt assistance in case of emergencies or accidents. Additionally, the armband serves as a reminder tool, providing alerts and notifications for hydration, Weather, and safety protocols. The system's development involved extensive research, analysis of user requirements, and collaboration with the street sweepers and CENRO Calamba City. The armband's design and functionality were optimized to suit the specific needs and constraints of the street sweeping operation. Preliminary testing of the E-Health Armband Reminder demonstrated promising results, showing improved task management as the Attendance monitoring and increased safety awareness among the street sweepers.

***Keywords:*** Street sweeper; Node-MCU; GPS Tracker, Attendance; E-health Armband Reminder; CENRO;

## I. INTRODUCTION

The World Health Organization (WHO) reported in 2016 that extended work hours contributed to 745,000 deaths from heart disease and stroke, a 29% rise since 2000. A thorough investigation into the effects of long work hours on health and mortality was done by the WHO and the International Labour Organization (ILO). They discovered that working a minimum of 55 hours per week caused at least 398,000 stroke deaths and 347,000 heart disease deaths in 2016. Long work hours were linked to a 42% increase in fatalities from heart disease between 2000 and 2016 and a 19% increase in deaths from stroke. According to a study by Munzel et al. (2021), non-communicable diseases (NCDs) cause more than 38 million deaths per year and account for 70% of all deaths worldwide. The main factor causing these fatalities is cardiovascular disease (CVD). Exposure to environmental stressors such as air pollution, noise, artificial light at night, and climate change-related events like excessive heat, desert storms, and wildfires are all known to increase the risk of NCDs.

Calamba City Laguna's City Environment and Natural Resources Office (CENRO) is in charge of keeping the streets clean and sanitary. The arduous effort of street sweepers, who maintain the streets clear of waste and debris, is essential to this mission. However, the health risks associated with their work might have an extended negative impact on their wellbeing, such as dehydration, heat exhaustion, and muscular injuries. It's critical to keep an eye on their whereabouts in regions with high traffic or crime rates because these situations raise safety concerns. Creating a health monitoring and alerting system based on the Internet of Things (IoT) is a creative solution to these problems. This gadget would measure several bodily characteristics, like heart rate and temperature, while using less power and being more affordable. Street sweepers would be able to move around freely and take part in daily activities while gathering data because of the device's portability and small size. Web applications would be able to access the collected data, which would be kept in a cloud database. This wearable technology, which may come in the form of an armband, attempts to improve the comfort and wellbeing of people, such as street sweepers, while they are at work.

## II. BACKGROUND

Continuous monitoring of a person's physical activity, vital signs, and other traits is possible because of wearable technology. It can be incorporated into skin-attachable devices as well as diverse accessories like watches and apparel. These devices use sensors like ECG and BCG to gather information such as heart rate, blood pressure, body temperature, and physical activity. Wearable technology links to the Internet to exchange data and has uses in sophisticated textiles, healthcare, and navigation. For activities like gait analysis, it is frequently used in conjunction with cellphones and data analysis systems.

Due to their duties, street sweepers are exposed to physical, chemical, and biological hazards. In underdeveloped countries without proper safety measures, they are exposed to dust. For street sweepers, a GPS tracker can be used to address these problems, improving their well-being, output, and safety. They can respond to emergencies while having their location and progress tracked by the tracker. Street sweepers can be reminded to take breaks and drink water by wearing an E-Health armband reminder with a GPS tracker. This technology makes it easier for employees and managers to communicate and makes the workplace safer. In conclusion, wearable technology makes it possible to continuously monitor physical activity and vital signs. Street sweepers encounter health dangers; therefore, using a GPS tracker and an E-Health armband reminder together can improve their safety and well-being.

This study aimed to design and develop a web-based wearable device that will help monitor the health conditions of street sweepers while at work and, at the same time, track their attendance and location when at work.

### *A. Research Objectives*

Generally, this study hopes to develop an E-Health Armband Reminder with GPS Tracker for Street Sweepers of CENRO Calamba City, Laguna that will enable street sweepers to monitor their health as well as remind them about the weather, increase their effectiveness in identifying areas that need to be swept, and establish a trustworthy attendance recording system.

Specifically, the study sought to achieve the following objectives:

- To develop an E-Health armband that can monitor the heart rate and body temperature of the street sweepers while working.
- To develop an E-Health armband with a GPS tracker to show the exact location of the street sweepers when an incident happened while working.
- To develop an E-Health armband that can record the street sweeper's attendance even without going physically to the City Hall or Barangay Hall.

## III. METHODOLOGY

### *A. Research Design*

The researcher used a prototyping model, which is a scientific and organized strategy that ensures a systematic and progressive deployment of the system, to direct the development of the system. The system was broken down into phases, with each phase building on what came before it. The researcher diligently finished each phase before moving on to the next to ensure that the E-Health Armband Reminder with GPS Tracker for Street Sweeper was implemented successfully.

The crucial concept to grasp is that a prototype serves as a working model. It might not have all the functionality you want, and there might be some bugs. Its primary objective is to perform as anticipated, and it frequently works in a production environment, even if just temporarily. The purpose of prototyping is to cut down on development costs and speed up the process. The basic idea is that a functional model, as opposed to comprehensive documentation like user requirements, system specifications, flowcharts, and disclaimers, gives a simpler understanding of the system being developed.

### *B. Development Methodology*

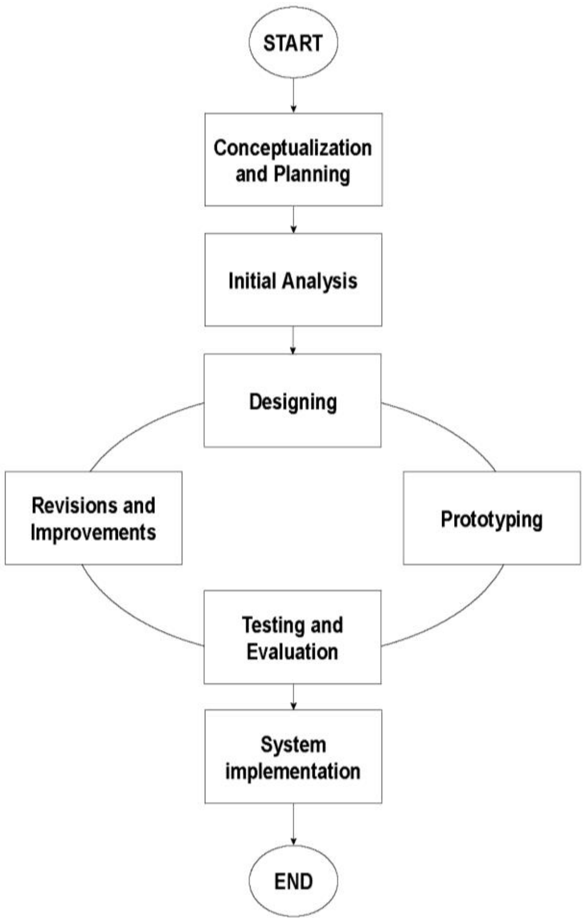


**Figure 1:** Prototyping Model

In order to guide the system's development, the researcher employed a prototyping model, which is a methodical and well-organized approach that guarantees a systematic and incremental implementation of the system.

 

The system was divided into phases, with each subsequent phase building upon the accomplishments of the preceding one. Figure 3 illustrates the prototyping model, which played a crucial role in guiding the project's execution. The researcher diligently completed each phase before advancing to the next, ensuring the effective implementation of the E-Health Armband Reminder with GPS Tracker for Street Sweeper.

***Conceptualization and Planning***

In this stage involves Conceptualization and Planning the development of an innovative solution known as the E-Health Armband Reminder with GPS Tracker for Street Sweepers. This technology aims to optimize the efficiency and effectiveness of street sweeping activities carried out by the CENRO Calamba City in Laguna. The Conceptualization of the prototype is to enhance street sweepers' productivity by providing them with a smart device that assists them in their daily tasks. It also aims to improve their safety by incorporating a GPS tracker to monitor their location and well-being. Moreover, the solution intends to minimize manual errors and enhance efficiency by implementing automated reminders and notifications for street sweeper.

***Initial Analysis***

The occupation of street sweeping carries certain health risks. Street sweeping is a physically demanding occupation that involves exposure to various environmental conditions. The nature of the job can expose street sweepers to various health risks, including heat stroke, dehydration, and body temperature irregularities due to changes in weather conditions.
With this, the researchers came up with an innovative idea to develop a device that can monitor various vital signs, including heart rate and body temperature. The device is designed to help street sweepers stay healthy and safe while performing their duties. The device also includes a drinking water reminder and a weather notification system, which can further assist street sweepers in protecting themselves, and an Attendance Monitoring for the CENRO.

***Designing***

In this phase, researchers create a preliminary version of the system, either in paper or digital form, to evaluate ideas and provide explanations for the chosen feature set and overall design concept. Making adjustments to a component at this early stage of development proves to be much more cost-effective compared to making changes after the design has been fully implemented.

***System Architecture***

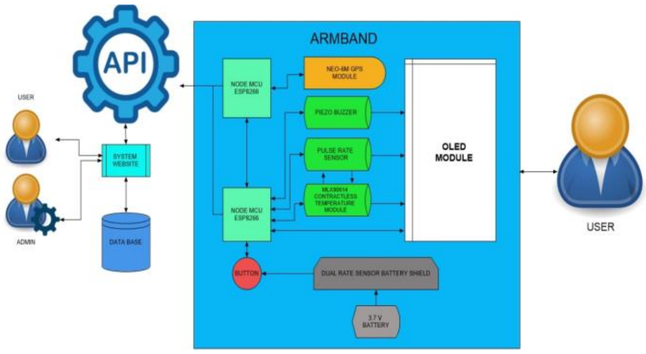


**Figure 2:** System Architecture

The system architecture is depicted in the figure 2 above, and the login form asks users or administrators to provide their username and password. The administrator or user can access the data gathered by the device after successfully signing in. The administrator can also add or remove users and accept or reject time-in requests. While a user can only request a time to read the data. The button that will let the current power up the additional electronics is where the armband architecture begins. We can see the two node MCUs in the architecture that will be used for the sensor system of the device, which comprises the pulse rate sensor, the body temperature rate sensor, and the buzzer. Another node MCU is used for the device's GPS function. Finally, the user can observe the data that the sensor system has collected, which is also presented on the LED.

***Block Diagram***

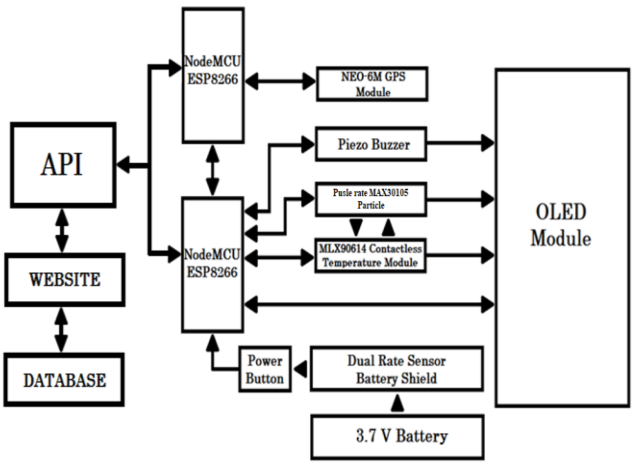


**Figure 3:** Prototype Block Diagram

Figure 3 shows the block diagram of the sensor and monitoring system; the system is powered by 2 pieces of 3.7 V battery. The first node MCU for the sensor system is connected to the piezo buzzer which is responsible for the water hydration reminder of the system, pulse rate sensor that collects the current pulse rate of the user and a body temperature rate sensor that collects the current body temperature of the user. This sensor is responsible for gathering the data from the user and the data gathered is displayed in a OLED Module while another node MCU powered up by the same power source is connected to a GPS module which is responsible for determining the current location of the user all this data are process by the 2 node MCU and sent to an API and stored in the database. The data gathered is also uploaded to a website and the user and admin can see the data in real-time.

***Flow Chart***

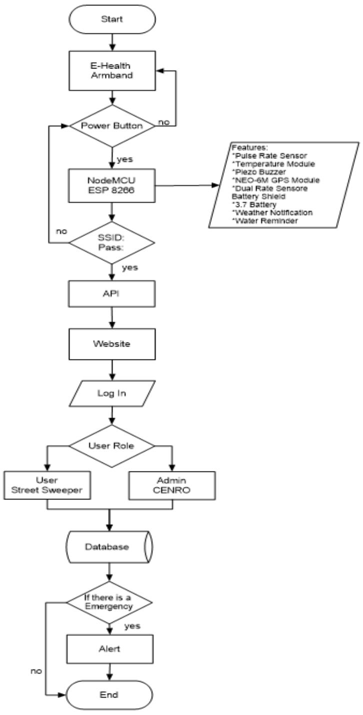


**Figure 4** System Flow chart

The figure 4 above shows the system flow chart. The user will first check if the device is on or off; if the device is off, nothing will happen. If the device is on, the node MCU will be powered up along with all the sensors and modules, and it will ask for a SSID and Pass. The system will continue to ask until it is provided. After that, the system will proceed to export the data collected to the website. On the website, the user is asked to log on, and the system will check if there is an emergency; if there is, it will send an alert; otherwise it will continue monitoring.

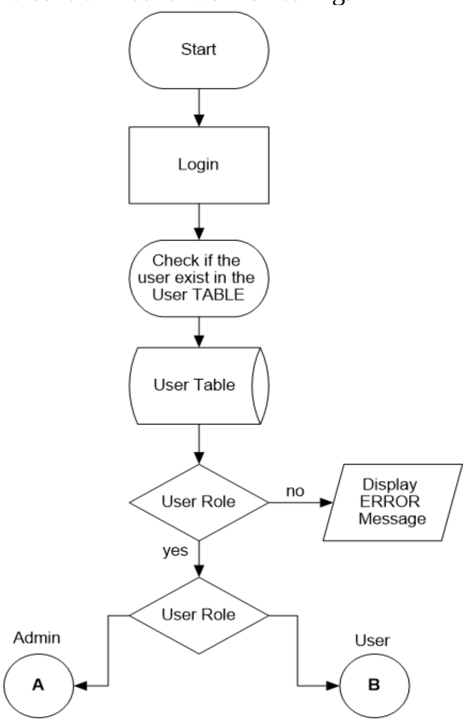


**Figure 5** Flow chart of Website Login

Figure 5 shows the flow chart of the website login, the user will open the website and input the his/her credentials the system will check if the user exists in the database of the user table if the user is not in the data base it will display and error message if the user is in the database the system will determine if the user is an admin or a user.

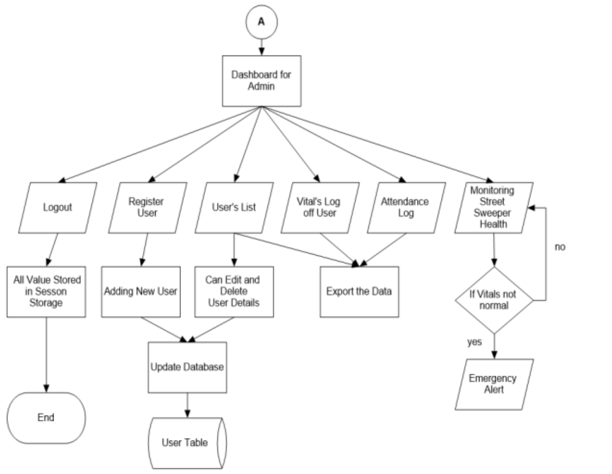


**Figure 6:** Flow Chart of the Administrator Website

Figure 6 shows the flow chart of the administrator website, the admin will log on his/her account and open the administrator dashboard in the dashboard there are multiple options. If the admin chose to register another user the system will proceed to asking for the new user information and then it will be stored in the database of the user table. If the admin chose to view the user's list he/she can edit and delete users that are already in the database and any action done will be saved in the database of the user table. If the admin chose the vital's log of the user and the attendance log the system will export the data gathered by the device and display it for the admin. If the admin select the monitoring street sweeper health the system will check if the user's vitals are normal if it is not then it will send an emergency alert if the vital's are normal the system will continue to monitor if the admin select the logout the system will store all the data for the session and end the program.

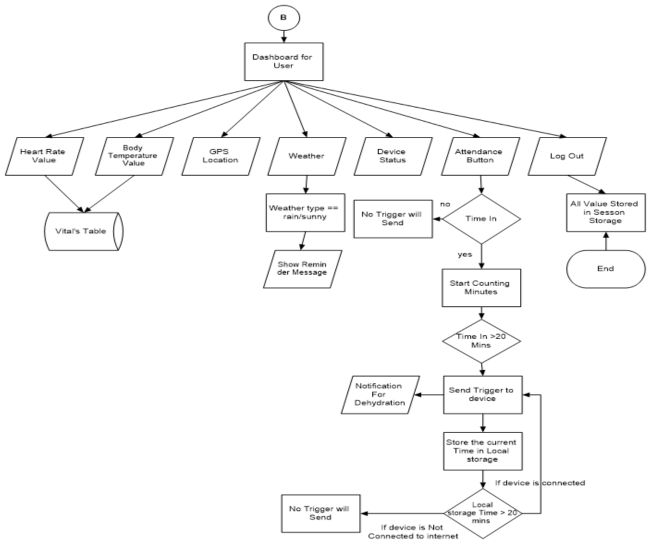


**Figure 7**: Flow Chart of the User Website

Figure 7 shows the flow chart of the user website, the user will log on his/her account and open the user dashboard in the dashboard there are multiple data's display. The user can view the current heart rate and the current body temperature which is exported from the database. The user can also view the GPS location. In the weather display the user can see a reminder if the weather is rainy or sunny and the user can also view the status of the device if the device is connected or not. The user can also select the attendance button where he/she can time in. If the user timed in the reminder function of the device will start counting and if the user is timed in for more than 20 minutes the device will trigger the buzzer to remind the user to drink water this function will trigger every 20 minutes if the device is disconnected from the internet no trigger will be send. If the user selects to log out all the data for the session will be stored in the database and the program will end.

***Prototyping***

To solve the different problems encountered by street sweepers while doing their duties, the project's proponents developed a project design. These problems include not keeping an eye on their physical condition and failing to remind them to wear the appropriate safety equipment to protect their health.

The project's supporters started building websites while the system was being developed using a variety of tools and technologies. This comprised Bootstrap, Figma, MySQL, Javascript, C++, Javascript, Hypertext Pre-processor (PHP), Application Programming Interface (API), and MyStructured Query Language (MySQL). These tools and technologies were used to speed up the creation of the webpages and guarantee their usability, interactivity, and aesthetic appeal.

The project's developers began looking for a programmable microcontroller appropriate for the wristband as they developed the prototype. After giving it some thought, they decided on the Node MCU ESP8266, a reasonably priced line of microcontrollers with built-in Wi-Fi that are renowned for their low power consumption. The advocates built a temperature sensor and a heart rate sensor into the device to allow for monitoring of the street sweeper's physical state. A GPS module was also incorporated into the device to help with the difficulty of tracking the street sweeper's location while they were working. A mobile hotspot was used to satisfy the need for internet connectivity. The supporters chose to buy a ready-built case made expressly for using an armband as the armband casing.

C. ***Data Collection Methods***

The researcher used three (3) methods in collecting data as Interviews, Internet Research, and Surveys/Questionnaire.

***Interview***

The researcher obtained relevant information from CENRO of Calamba City, Laguna, for a study to produce an E-Health Armband Reminder with GPS Tracker for Street Sweepers of CENRO Calamba City, Laguna. The study aimed to empower street sweepers by monitoring their health, reminding them of the weather conditions, improving their efficiency in locating areas that require sweeping, and establishing a reliable attendance recording system.

***Internet Research***

The study used online sources such as Google Books, Google Scholar, e-books, and e-journals as sources of information, compiling a variety of pertinent information. The study used the various online resources for IOT-based health monitoring that are readily available. This information was used to gather the resources required to create the system's several complex modules. Additionally, research on the prospective characteristics and functionalities of the desired final product of the study was conducted online. The researcher looked for theories, notions, details, and procedures pertaining to IOT-based health monitoring. In order to obtain only the information relevant to the research study from the large amount of material available, the researcher carefully picked and filtered the data. With the help of the data acquired, the researcher was able to produce original concepts and ideas for the E-Health Armband Reminder with GPS Tracker for Street Sweepers of CENRO Calamba City, Laguna.

## IV. RESULTS AND DISCUSSION

**Figure 8:** System Prototype

This represents the complete prototype of the system, comprised of various components seamlessly integrated into a single device capable of performing multiple tasks. All the necessary initialization, data processing, and configuration procedures were executed within this device.

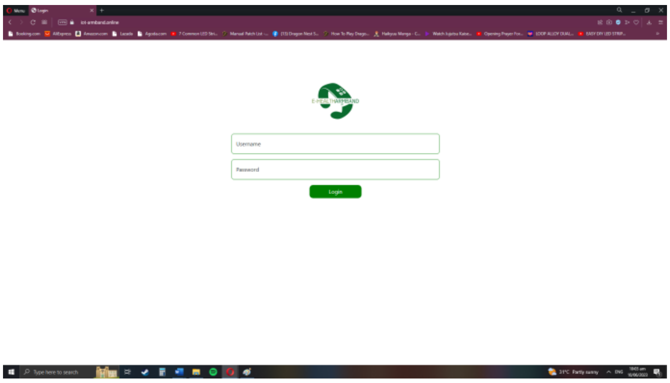

**Figure 9:** System log-in Website

Figure 9 shows the admin login website of the system where the administration will login the username and password to access the admin website using a computer desktop.

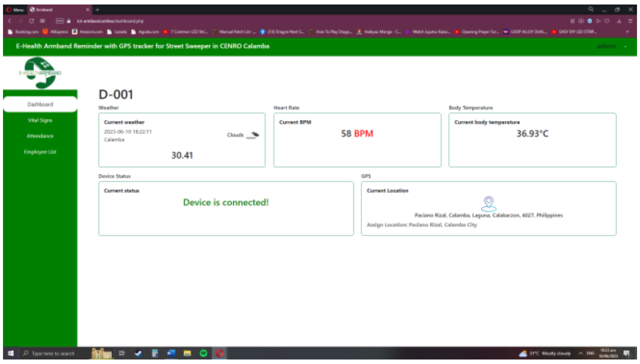


**Figure 10:** System Admin Website Device Dashboard

Figure 10 shows the admin login website dashboard of the system where the administration will see the real-time weather status, bpm reading, body temperature, device status and current location reading of the device.

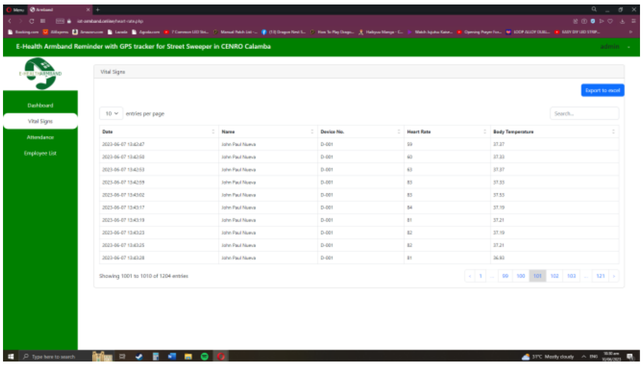


**Figure 11:** System Admin Website Vital Signs Record

Figure 11 shows the admin login website vital signs record of the system where the administration will see the real-time vital signs recorded by the system and can be exported to Excel file.

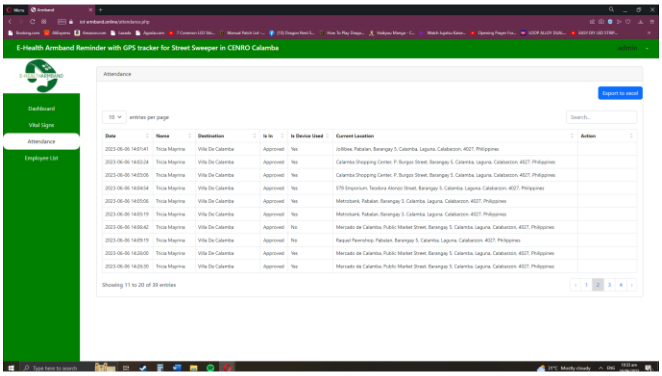


**Figure 12:** System Admin Login Website Attendance Record

Figure 12 shows the admin login website attendance record of the system where the administration will see the real-time attendance recorded by the system and can be exported to Excel file.

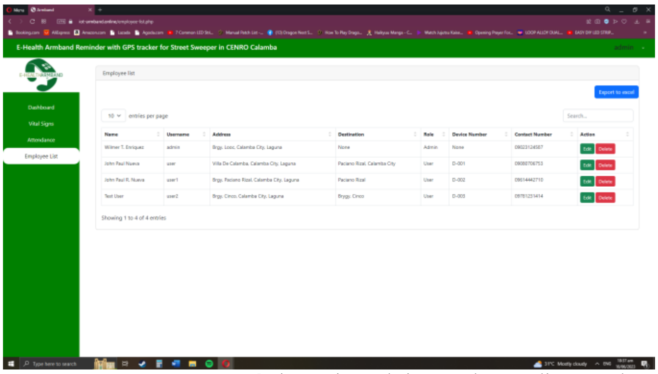


**Figure 13:** System Admin Login Website Employee's list record

Figure 13 shows the admin login website employee's list record of the system where the administration can register a new user and as the same time can edit and delete the employee's information.

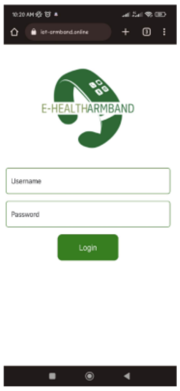


**Figure 15:** System User Login Website

Figure 15 shows the user login website of the system where the user will login the username and password to access the user website using a smartphone.

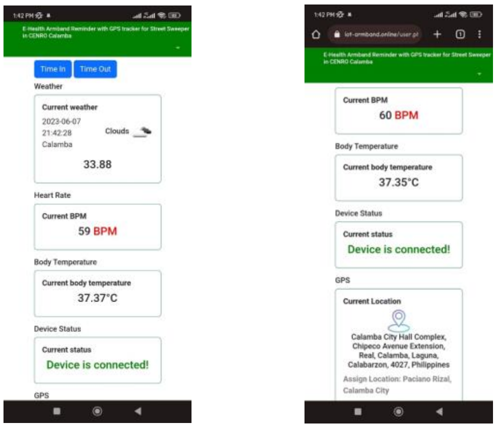


**Figure 15:** System User Login Website Dashboard

Figure 15 shows the user login website dashboard of the system where the user can see the real-time weather status, bpm reading, body temperature reading, device status and current location of the device as well as the time-in and time-out button for the attendance recording.

Table 1: Time Efficiency Testing of E-Health Armband VS Manual hand Bpm recording

| No. of Testing | E-Health Armband Bpm reading per sec. | Manual hand Bpm reading per sec. | Efficiency Rate |
|---|---|---|---|
| 1 | 1.2 | 21.3 | 94.37 |
| 2 | 1.4 | 22.3 | 93.72 |
| 3 | 1.6 | 20.1 | 92.04 |
| 4 | 1 | 19.5 | 94.76 |
| 5 | 1.1 | 17.2 | 93.60 |
| 6 | 1.3 | 24.1 | 94.61 |
| 7 | 1.2 | 19.8 | 93.94 |
| 8 | 1.5 | 22.7 | 93.39 |
| 9 | 1.1 | 20.5 | 94.63 |
| 10 | 1.3 | 19.1 | 93.19 |
| 11 | 1 | 16.3 | 93.87 |
| 12 | 1.4 | 18.4 | 92.39 |
| 13 | 1.2 | 22.1 | 94.57 |
| 14 | 1.1 | 18.2 | 93.96 |
| 15 | 1.2 | 21.6 | 94.44 |
| **Total Average Efficiency:** | | | 93.83 |

Table 1 shows the result of the experiment conducted using E-Health Armband Reminder with GPS Tracker for Street Sweepers of CENRO Calamba City, Laguna. The time efficiency rate of E-Health Armband versus Manual Hand Bpm recording is 93.83%, with an average efficiency rate per seconds of 92.04%. to 94.96%.

Table 2: Time Efficiency Testing of E-Health Armband VS Digital Thermometer Body Temperature recording

| No. of Testing | E-Health Armband Temperature reading per sec. | Digital Thermometer Temperature reading per sec. | Efficiency Rate |
|---|---|---|---|
| 1 | 1.2 | 31.7 | 96.21 |
| 2 | 1.4 | 30.5 | 95.41 |
| 3 | 1.6 | 29.4 | 94.56 |
| 4 | 1 | 30.6 | 96.73 |
| 5 | 1.1 | 32.2 | 96.58 |
| 6 | 1.3 | 33.3 | 96.10 |
| 7 | 1.2 | 30.1 | 96.01 |
| 8 | 1.5 | 31.8 | 95.28 |
| 9 | 1.1 | 32.7 | 96.64 |
| 10 | 1.3 | 30.1 | 95.68 |
| 11 | 1 | 31.1 | 96.78 |
| 12 | 1.4 | 32.3 | 95.67 |
| 13 | 1.2 | 29.7 | 95.96 |
| 14 | 1.1 | 31.3 | 96.46 |
| 15 | 1.2 | 30.3 | 96.04 |
| **Total Average Efficiency:** | | | 96.01 |

Table 2 shows the result of the experiment conducted using E-Health Armband Reminder with GPS Tracker for Street Sweepers of CENRO Calamba City, Laguna. The time efficiency rate of E-Health Armband versus Digital thermometer Body Temperature recording is 96.01%, with an average efficiency rate per seconds of 94.56%. to 96.96%.

### *A.* SUMMARY OF SYSTEM EVALUATION OVERALL MEAN SCORE

Table 3: Summary of System Evaluation Overall Mean Score

| **Particulars** | **Weighted mean** | **Interpretation** |
|---|---|---|
| Functionality Suitability | 4.62 | Outstanding |
| Reliability | 4.48 | Outstanding |
| Performance Efficiency | 4.57 | Outstanding |
| Operability | 4.63 | Outstanding |
| Security | 4.67 | Outstanding |
| Compatibility | 4.7 | Outstanding |
| Maintainability | 4.67 | Outstanding |
| **Group Mean** | **4.63** | Outstanding |

Table 2 demonstrate that the E-Health Armband Reminder with GPS Tracker for Street Sweeper of CENRO in Calamba City, Laguna underwent a comprehensive series of tests to assess its functionality, suitability, reliability, performance efficiency, operability, security, compatibility, maintainability, and portability. Based on the results, the system achieved an impressive total mean score of 4.63, denoted as "Outstanding/Extremely Satisfied." This indicates that both experts and clients expressed high satisfaction with the system's characteristics. Additionally, the system met the standard rating level of ISO/IEC 25010, further validating its quality. While evaluators noted that the system would benefit from some improvements, overall, the system performed effectively and successfully accomplished its goals.

## V. CONCLUSIONS

The E-Health Armband Reminder with a GPS tracker, designed specifically for street sweepers in CENRO Calamba City, Laguna, is designed to empower street sweepers in monitoring their health as well as reminding them of the weather conditions, improving their efficiency in locating areas that require sweeping, and establishing a reliable attendance recording system. By leveraging the power of the ESP8266 node MCU and IoT technology, this system enables an accurate notification system, health monitoring capabilities, and a tracking mechanism that prioritizes the well-being and safety of street sweepers in the City of Calamba.

The following conclusions are provided based on the objectives of the study and the findings of the evaluation:

1. The system can monitor the heart rate and body temperature of the street sweeper while he or she is working.
3. The system can also track the location of the street sweeper using the GPS tracker. The user and the admin can view the current location via the web using the website developed by the proponents.
4. The system also has an attendance system that can record the street sweeper's attendance even without going physically to City Hall or Barangay Hall.

## VI. ACKNOWLEDGMENT

The researchers express their deep gratitude to the following individuals who provided invaluable assistance throughout the planning and execution of the study:

Firstly, they acknowledge the Almighty God for granting them the strength to overcome obstacles and complete the study successfully. They recognize that divine assistance played a significant role in achieving their goals.

They are also grateful to their parents and relatives who served as a constant source of inspiration and provided unwavering support throughout their academic journey. The love, patience, and trust bestowed upon them were instrumental in their pursuit of knowledge.

Engr. Mark Angelo T. Mercado, the Program Head of the Department of Engineering and Computer Studies, deserves special recognition for his unwavering support, guidance, and expertise. His valuable insights and commentary on the study's relevance enriched the research process and contributed to its success.

Mr. Harrold M. Gueta, as the diligent and responsible advisor, played a crucial role in the study's completion. The researchers appreciate his dedication, guidance, and the valuable suggestions and ideas he shared, which significantly contributed to the successful conclusion of the study.

Lastly, the researchers extend their gratitude to all individuals who provided support, valuable suggestions, and guidance throughout the study. They express their special thanks to their cousins, close friends, classmates, old classmates, and old professors, as their presence and contributions were essential for the study's successful outcome.

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