CHAPTER 1 INTRODUCTION TO THE STUDY

Background of the Study and Theoretical Framework

The Covid-19 pandemic impedes the movement of individuals due to restrictions set by governing bodies to mitigate the spreading of the highly fatal, contagious and infectious disease. Different methods have been adopted in order to contain the disease that could wipe out the entire population if not managed.

As of May 2023, the recorded deaths brought by the highly fatal respiratory disease was over 6.87 million people since the pandemic began (Elflein, 2023). The highly transmissible disease is capable of infecting individuals at a higher rate and can be transmitted mostly through respiratory droplets (WHO,2020). But with all the restrictions and protocols that need to be followed, individuals find it difficult to practice them in their daily life due to all sorts of factors such as the nature of their work, etc. While the wearing of equipment has been sought-after (e.g. portable air purifiers, virus particle detecting apparatus) at the height of pandemic, this is not enough to protect

individuals from getting the disease, the most important aspect of prevention is proper wearing of face masks, maintain social distancing, avoid crowded enclosed areas and sanitizing of hands from time to time. The researchers found that 39.8 percent of respondents reported not complying with social distancing recommendations in the middle of March (De Witte, 2020) and based on the analysis of Kalluri in forty-six (46) countries that implemented social distancing policies prevented more than 1.5 million cases of COVID-19 in a span of two weeks which is equivalent to a 65% reduction in new cases (Boldt, 2020). Social distancing measures were proven to control the further propagation of the disease but this has been neglected. Collected in the inner-city Amsterdam, people complied with the 1.5-meter distance directives when these directives were first introduced, but that the level of compliance declined soon after (Baak et al., 2021). Initiatives of the Philippine government to provide timely, relevant and effective solutions to properly execute these protocols in public places were established. The public transportation sector where they mandate the installation

of plastic barriers which operate in a limited capacity, and provide proprietary markings on loading and unloading areas to maintain safe distance amongst passengers while they are waiting for their ride was also put in place. The other establishments created signage and stickers in the pathway to remind individuals to physically distance themselves from others; they even deployed employees that held placards to remind individuals from time to time to wear their mask and face shields as well as maintain a safe distance.

In line with the current situation, the researchers proposed A Social Distancing System using ESP32 Microcontroller and Bluetooth Low Energy for Peer-to-Peer Warning Signal that could prevent or reduce the propagation of the disease amongst individuals and to have efficient contacting tracing measures made possible by a proprietary database.

The development of a social distancing system using microcontrollers was highly relevant at the height of the pandemic to alert individuals about the ongoing battle. The practice of social distancing became a moral obligation for individuals to safeguard themselves and

the welfare of others from the highly fatal and contagious disease brought by COVID-19 but this has been neglected in the long run due to the exhaustion of different restrictions that regulate movements. Social and physical distancing measures aim to slow the spread of disease by stopping chains of transmission of COVID-19 and preventing new ones from appearing (WHO, 2020).

According to Misal, Niveditha, Prajwal, Veena, and Vinayaka (2020), Bluetooth Low Energy (BLE) is a communication technology for Internet-of-Things (IoT) with reduced energy consumption. It was designed with the aim of supporting Internet of Things (IoT) applications by using low-cost and low-power devices (Angelis, et al., 2021). The use of Bluetooth Low Energy technology greatly fits the study as it can cover the domain and blind spots of a human compared to ultrasonic sensors where you would need multiple ultrasonic sensors to cover the gray area/ blindspots.

Peer-to-peer (P2P) is a decentralized communications model in which each party has the same capabilities and either party can initiate a communication session. Unlike the client/server model, in which the client makes a

service request and the server fulfills the request, the P2P network model allows each node to function as both a client and server (Rosencrance, 2019). The use of the Peer-to-Peer network is crucial in the success of this study, because each device should exchange information that will be logged into the database as they come in close contact with each other for a period of 10 seconds.

Objectives of the Study

The aim of this study was to create a hardware solution that solves the noncompliance of individuals in the social and physical distancing measures and to incorporate a software that can record individuals who came in close contact with each other to assist in the mitigation of the spreading of the Covid-19 virus.

Specifically, the study targeted to attain the following objectives:

1. Develop a device using ESP32 microcontroller that will incorporate its built-in Bluetooth Low Energy (BLE) feature as a means of detecting other ESP32 BLE enabled devices.

2. Integrate a buzzer into the device that will activate whenever 1-meter physical distancing is violated and set a 10 second duration before the device logs the personal information of the other scanned devices.
3. Develop a system (Recede) that can interact with the device to store and provide real-time reports for users' contact tracing logs.
4. Evaluate the systems' quality and reliability using ISO 25010:2011 System and Software Quality Requirements and Evaluation Criteria.

Significance of the Study

The researchers believed that the outcome of this study would serve as a means of prevention of transmissions and improving the quality of contact tracing which is significant to the following:

Local Government Unit. The results and findings of this study would be beneficial to the LGU because they may have a resort if ever the current or similar disease

spreads across the locality. Monitoring of locals would be easier and faster with the use of this device.

West Visayas State University. In line with the gradual opening of classes, this study could help in the mitigation of the disease within the community. This could remind students and faculty to maintain a safe distance among their peers, it also enables an efficient contact tracing effort whenever someone got tested positive from the disease.

ESP32 Bluetooth Low Energy (BLE) Project Creators. This study may open up new possibilities and variety when it comes to project ideas. ESP32 BLE project creators can now expand, and work on the study's idea to supplement and possibly improve the projects they currently have.

Future Researchers. The results and findings of this study would help future researchers for their thorough investigation about the implementation of social distancing and contact tracing using Internet of Things during the course of pandemic.

Definition of Terms

For better understanding, the following terms were defined conceptually and operationally:

Bluetooth Low Energy (BLE) -- is a power-conserving variant of Bluetooth personal area network (PAN) technology, designed for use by Internet-connected machines and appliances (Phifer, 2014).

In this study, "Bluetooth Low Energy" (BLE) referred to the version of Bluetooth that was utilized as a means of detecting neighboring other ESP32 Bluetooth Low Energy (BLE) enabled devices within a specific domain set by the researchers.

ESP32 Microcontroller -- is a very versatile System on a Chip (SoC) that can be used as a general-purpose microcontroller with quite an extensive set of peripherals including Wi-Fi and Bluetooth wireless capabilities (Teel, 2021).

In this study, "ESP32 microcontroller" referred to the primary device module that was utilized by the researchers to develop a portable social distancing system.

Peer-to-peer -- Referred to as something that occurs directly between human peers, people who are similar in age, grade, or status (Merriam-Webster Dictionary, 2022).

In this study, "peer-to-peer" referred to the individuals that used the social distancing system, who were the subject of this study. Also, peer-to-peer referred to the network of devices that can either send or receive information of close contact individuals.

Recede -- to go or move back or further away from a previous position (Lexico.com, 2022).

In this study, "recede" referred to the term used to describe the physical distancing device with a preconfigured unique id that can scan for nearby ESP32 Bluetooth Low Energy (BLE) enabled devices.

Warning signal -- is an automatic signal (usually a sound) warning of danger (Vocabulary.com, 2022).

In this study, "warning signal" referred to the sound alarm that the buzzer produced when the subject violated the domain set by the researchers in their social distancing system.

Delimitation of the Study

The general intent of this study was to develop a social distancing system using ESP32 microcontroller and Bluetooth Low Energy that can alert individuals whenever they violate the guidelines set by the authority and to generate real time reports using a database that can be used for contact tracing. Initially, the study confined itself in the grounds of West Visayas State University - Main Campus. In the implementation of the study, the participants were only limited to the students and faculty/staff of West Visayas State University. In terms of the accuracy of the detection, the devices were found to be susceptible to interference such as obstacles that could hinder the transmission of BLE scanning.

CHAPTER 2 REVIEW OF RELATED STUDIES

Review of Existing and Related Studies

In the study of Surya and Yarlagalda (2020) "AI Economical Smart Device to Identify Covid-19 Pandemic, and Alert on Social Distancing WHO Measures", the researchers developed an AI smart device designed to resemble a wristwatch. The devices have two features. First, the user is notified if someone they interact with has Covid-19. Second, when they violate the social distance limits of 6 feet. The passive infrared sensor is the most important component of this device. It is used to detect two people in close proximity by calculating the distance between them on the measurement frame. Some of the components that were included in this device are the sensors, buzzer, display, and microcontroller. Using sensors, this smart device was able to read data. The thermal sensor detects an individual's temperature and display data on the screen. When the temperature exceeds 37 degrees, the thermal effect alert is activated. This research included software that permits the registration

of signals from several detecting zones in order to record the measurements.

Recede also included the social distancing problem similar to the study. Recede also used a carriable device, but in the form of ESP32 microcontrollers. The ESP32 uses its Bluetooth Low Energy (BLE) functionality as the method of detecting the proximity of the other ESP32 microcontrollers and has a buzzer to produce warning signals whenever social distancing is violated.

Furthermore, in the study of Alfatmi, Deshmukh and Kulkarni (2021) "Social Distancing Using IoT Approach" presented a social distancing wristband that utilized PIR (Passive Infrared) sensors to detect the presence and distance of individuals based on threshold distance, a speaker jack would be used as an audio signaling device to alert users about the presence of an individual in a 2 meter radius, a buzzer that alerts both the wearer and the person that was detected by the PIR sensor if the distance is 1.5 meters or less which indicates the violation of social distancing measures, will not stop until the wearer presses the push button. In the heart of

this device lies the arduino lilypad which controls all the operations (Alfatmi, 2021).

The proposed wristband can detect individuals in all directions due to the fact that it uses multiple PIR sensors. This wearable device can call the attention of individuals to sanitize their hands from time to time but the significant motivation in the creation of this device is to maintain social distance in the mitigation of the spreading of the highly infectious and contagious disease.

Recede relates to the above study but used Bluetooth Low Energy (BLE) and was also able to detect from all directions. The researchers also incorporated a buzzer on each ESP32 microcontroller that alerts the carrying respondent if another respondent with an ESP32 microcontroller of Recede is nearby or within 1 meter of distance.

Moreover, Aborakbah and Alhmiedat (2021) developed a "Social Distance Monitoring Approach Using Wearable Smart Tags" that could monitor and observe social distancing measures using a microcomputer raspberry pi with embedded camera and proximity/ultrasonic sensor to determine the

distance of approaching individuals. The researchers utilized OpenCv to process the footage from the camera whilst applying face and eye detection methods to determine approaching humans. The study took place in Saudi Arabia, the researchers considered women wearing Niqab, that is the very reason why their system has eye detection. They also make use of Ultrasonic sensors that could estimate the distance between the wearer of SD-tag and the humans in front of them. It provided a warning depending on the distance of the approaching person. The SD-tag can detect if there is a crowd and it alerts the surrounding SD-tag users through continuous beeps. Lastly, the researchers have deployed a four long ranged access point to obtain various information from the SD-tags and a base station where the data that the SD-tag can collect was stored in an integrated database. It can determine crowds via collected data hence it can send a warning signal to the users to avoid the area. To conclude, the system that the researchers developed to monitor and maintain social distancing restrictions was effective though there was a loophole in the system. It

only detected a person from the front and was unable to detect the person from the back or from the side.

Recede relates to this study by also including the social distancing problem with the use of a wearable or carriable device. Recede on the other hand used Bluetooth Low Energy (BLE) on each of its microcontroller devices to detect other nearby microcontrollers. Recede also has a warning prompt that also beeps, if two or more microcontrollers are in close proximity with each other.

The paper of Montanari, Nawaz, Mascolo, and Sailer (2017) entitled, "A Study of Bluetooth Low Energy Performance for Human Proximity Detection in the Workplace" presented an extensive evaluation of Bluetooth Low Energy (BLE) as the technology to monitor people's proximity in the workplace. The researchers studied how the system can be implemented on popular wearable devices (i.e., Android Wear and Tizen) and the resulting limitations when implemented. The results implied the applicability of BLE (Bluetooth Low Energy) for workplace interaction recognition and gave recommendation to vendors and Operating System (OS) developers on the impact of the restrictions regarding the use of BLE on

wearable devices. The paper highlighted the achievability of workplace interaction studies using popular BLE wrist-worn apparatus: the paper has explored the limitation area through a prototype platform on which BLE could be used without constraints. This allowed us to conclude the proximity detection power of COTS (commercial off the shelf) devices (e.g., smartphone, tablet) and a discussion of the limitations.

Recede utilized the same technology in the study which is Bluetooth Low Energy (BLE) to detect the proximity of individuals involved in the Recede system, but used the proximity data to produce warning signals whenever the minimum physical distance in the study is violated.

Gayathri, Shibu, Gopinath, Rao, Harika, Vijay, & Raghav, (2020) conducted a study entitled, "Suraksha: Low Cost Device to Maintain Social Distancing during CoVID-19". The researcher created a smart wearable device, Suraksha, that can be worn while traveling outside and will help maintain social distancing. The Suraksha device helped the user in maintaining a minimum physical distance from people and objects by sounding a buzzer

alarm and LED whenever anyone comes within close proximity of the user. The wearable device consisted of PIR motion Sensors, Buzzer, LED, Battery, Switch, Jump Wires and a microcontroller device with a built-in Bluetooth and Wi-Fi module. This device, which is basically a "cap", can be worn by anyone, anywhere as it is reliable and easy to use.

Recede is similar to this study for it has the same main objective which is to help maintain social distance to prevent CoVID-19 virus spreading. Recede used a device that is also being carried by the user. Recede's microcontroller devices use Bluetooth Low Energy (BLE) and buzzers, to alert users of other nearby users within close contact. Recede on the other hand utilized the Wi-Fi feature to connect to the database when uploading contact tracing data.

Moreover, Bensky (2020) study entitled, "A No-Phone/No-App Contact Tracing Hardware Token", utilized Bluetooth Low Energy (BLE) with the use of a microcontroller, ESP32. The token is used as a contact tracing module. The researcher made a software that can be flashed into the token and at the same time can be

used as a way for the computer to communicate, incorporate data, view data and also take the data from the ESP32 token. The data is a list of symptoms the user is currently feeling, e.g. muscle pain, cough, sore throat, etc. These types of data are set into the token as a current status of the user of the token. When in use, also with the other tokens, the data is always Bluetooth broadcasted and as a close contact event occurs, exchange of data is done where the token saves the other token's information, in this case, the other close contacted user's current symptoms. Each token has a unique identifier which is a series of letters and numbers as a way to differentiate one from another. At the end of the day of use. The user accesses the data through the computer and views the data saved (the symptoms) together with that token user's unique identifier.

Recede is closely related to this study. The researchers utilized ESP32 and its Bluetooth Low Energy (BLE) capability to create the contact tracing functionality. In the device, the researchers used unique IDs for each device as a method to differentiate one

device from another. Based on the ID one device has scanned, it will save the person's information related to that scanned device.

The study of Sanjaya and Utomo (2022) entitled, "Microcontroller-based supporting tool for socializing in physical distancing during Covid-19 pandemic", presents the use of two wristbands in each wrist that are calibrated to detect even in blind spots which are on the right and left side respectively. The study aims to provide a modular device that could help in the mitigation procedure to avoid the spreading of COVID-19 by practicing the physical and social distancing. The study made use of Arduino Nano as the control system, an ultrasonic sensor to measure and set the preferred distance of detection, a Passive Infrared (PIR) sensor to detect human movements, a vibrating dc motor to notify users to maintain a safe distance, a servo motor to drive and maintain both the ultrasonic and PIR sensors by 120 degrees angle detection with an exact 1 meter distance.

Recede relates to this study by also using a microcontroller (ESP32) as the main device for the operation. Recede has one individual carry one ESP32

microcontroller for the system. We also made a social distancing feature, but with the use of Bluetooth Low Energy (BLE).

In the study of Yuliza et al., (2021) entitled, "Physical Distancing Alarm System Based on Proximity Sensor and Microcontroller". This study attempted to provide a modular device that can be used for social distancing measures that could prevent the propagation of Coronavirus via respiratory droplets that became the primary media for transmission. This device utilized an Arduino Nano to control the sensor and other peripherals that made up the system. They utilized ultrasonic proximity sensor HC-SR04 for detecting the distance of an object, this sensor can be calibrated to detect at a certain distance, but the preferred safe distance is 1-2 meters. As a form of warning signal that would notify both the violators a buzzer was utilized, it automatically engaged when the distance to the object is less than the allowed distance. To power the system, they equipped it with a portable battery that is capable of being charged. Furthermore, this device was developed in the form of an ID card which can be hung in a pocket or

bag. This device can be either a single or dual type which implied that there can be two separate devices hanging on different places simultaneously for a more accurate and effective implementation of social distancing.

Similar to this study, Recede utilized a microcontroller in the form of ESP32, a detecting mechanism for proximity distance and a buzzer for the warning signal. The difference was that this study used an ultrasonic sensor for detecting the proximity, but Recede utilized the ESP32's Bluetooth Low Energy (BLE) functionality as a means to detect other ESP32's proximity.

In the study of Keller et al., (2021) entitled, "The case for wearable proximity devices to inform physical distancing among healthcare workers" implemented the use of wearable proximity beacons among healthcare workers in a non-COVID inpatient unit. This was to highlight the possible use of it for trackable technologies in the healthcare settings. The health care workers were tasked to stay 6 feet apart from each other while also wearing the tags. The devices recorded the interactions that

happened less than 6 feet apart and interactions that happened 5 seconds and more. In the discussion, the pilot study revealed that the wearable beacons can be used to quantify the interactions of health care workers in the inpatient settings. The study concluded that technology can be used to track health care workers' physical distancing.

Recede closely relates to their study by having an individual wear or carry a proximity device, but on the other hand implemented a warning signal mechanism for whenever physical distancing was violated. Together with it, a contact tracing mechanism was implemented. The tracing happens when an individual comes in close contact of less than one (1) meter of distance with another individual in at least ten (10) seconds of being in close contact.

Lastly, in the study of Abdul-Rahaim, Abdulsada, and Al-Hamiri (2021) entitled, “Applications of artificial intelligence with cloud computing in promoting social distancing to combat COVID-19”. The researchers proposed a system that could promote social distancing inside a classroom to combat Covid-19. They utilized a local host

server using cross-platform Apache, MySQL, PHP and Perl (XAMPP) interfaces to introduce the inclusion of cloud computing in the system. This study utilized 2 arduino NodeMCU WiFi to build the system. The first microcontroller was attached with various sensors and peripherals (i.e., 2 ultrasonic sensors (one for the entrance and the other for the exit), buzzer, solenoid lock, relay and IR temperature sensor). The other microcontroller is where the RFID is connected because all the pins are used but the two microcontrollers are connected by WiFi via a router. RFID was used to be an identification in order to enter the classroom contactless, while the sensors aforementioned are used to authenticate student whether they meet the conditions (i.e., number of students inside the classroom must be less or equal to the maximum number allowed, and the temperature of the student with a threshold of 37.5 degrees or less are allowed to enter while students with temperature more than the threshold solenoid lock will automatically shut and the buzzer will trigger an alarm in addition the temperature and the time of contact (with the Ultrasonic sensor) of that student will be stored).

The ultrasonic in the exit will permit students wherever they want to. The web server will act as a counter of the actual number of students inside the classroom, whenever someone gets inside the count will increment and when they leave, it will decrease, to maintain the limited and safe capacity of the classroom.

Recede closely relates to the study of Abdul-Rahaim, et al (2021) entitled Applications of artificial intelligence with cloud computing in promoting social distancing to combat COVID-19 though they implemented the system inside a closed space to limit the actual number of students inside the classroom and the system is tucked into the entrance and exit point of the classroom and it uses Ultrasonic sensor to measure the distance and a buzzer to prompt the warning signal. Recede also utilizes the XAMPP interface as a locally hosted web server to store information. Recede is different in many ways because it is a compact device made to be hand carried and it utilized BLE to measure the distance whilst recording the personal information of the closed contact individuals. Recede will only alarm the buzzer if someone violated the 1 meter distance though in the study

aforementioned above the buzzer will trigger if the temperature was higher than the threshold.

CHAPTER 3 RESEARCH DESIGN AND METHODOLOGY

Description of the Proposed Study

In line with the current pandemic situation, the researchers proposed A Social Distancing System using ESP32 Microcontroller and Bluetooth Low Energy for Peer to Peer Warning Signal that could potentially prevent/reduce the propagation of the Covid-19 disease among individuals. The participants were given a device to be worn at school. The device was equipped with Bluetooth low energy and a buzzer module. If another device gets close to the other, the Bluetooth paired with each other and logged the identity of the user if the duration of contact was 10 seconds as a proof that they had a close contact. Then, the buzzer emitted a sound indicating that the users need to recede from each other. The data in the devices were stored in a system where only authorized personnel can access and were available for fourteen (14) days that can be used for contact tracing purposes.

Methods and Proposed Enhancements

To make the project possible, the researchers went through the 5 phases of the Agile model which were: requirements, design, develop, test, and deploy. During the development stage, the important components were the ESP32 microcontrollers and the buzzers. Once the devices were already equipped with the important components, the researchers proceeded with the coding of the hardware components. ESP32 microcontrollers were uploaded with firmware that triggered the buzzer once the set conditions were violated. In setting the conditions, the proximity was adjusted to one (1) meter which is the specified range and the device would go through a ten-second count before it can pair successfully with the other Recede. Service UUID was assigned to each device to distinguish it from other devices. Personal information such as names, course and section, and contact numbers were be uploaded to the database for contact tracing purposes. Lastly, the researchers developed a database that stored contact information and provided real time reports.

The process of contact tracing would take place if there was reported Covid-19 positive individual. The admin who took charge of the contact information stored in the database would notify individuals who had a close contact with the Covid-19 positive individual so that may isolate themselves and would get tested for Covid-19 to lessen or stop the possible outbreak of the disease.

This current project is comparable with the existing ones, like in the study of Sanjaya (2022) and Yuliza (2021) that only addressed the physical distance with the help of a buzzer and sensors such as PIR or Ultrasonic or, in the study of Aborakbah (2021), the logging of the event of interaction. In our device, the buzzer served as a warning prompt, BLE detection to identify the presence of other devices not less than 1 meter away and the data we logged in the database was not only the interaction, but also the details of the individuals who came in close contact with each other. With this feature, the details of the individuals can then be used to trace them in the event of Covid-19 infection.

Components and Design

Software Architecture

Figure 1 illustrates the software architecture of the system. For the development of the source code which was uploaded to the ESP32 microcontroller Arduino IDE was utilized. To enable data storage XAMPP localhost server, Apache, PHP, MySQL was used.

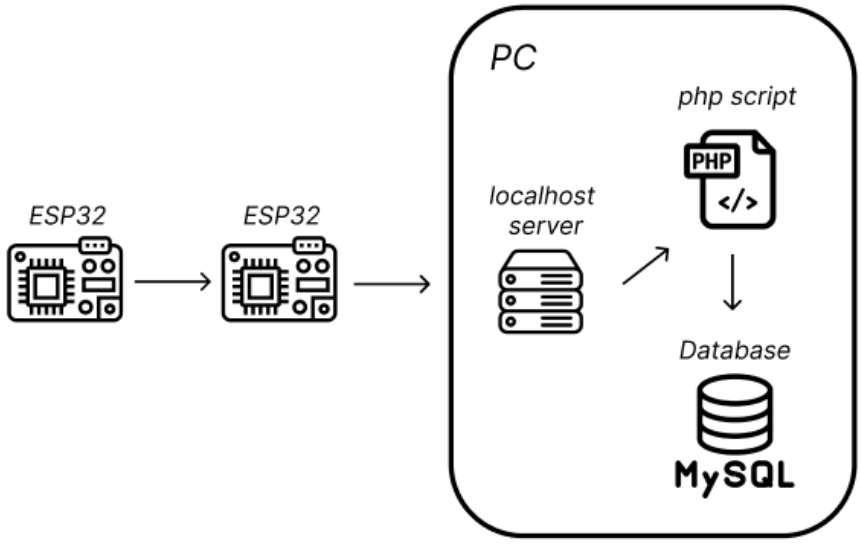


Figure 1. *Software Architecture*

System Architecture

Figure 2 illustrates the system architecture where it illustrates the flow of the system. The hardware devices utilized its Bluetooth Low Energy feature to scan

for nearby Bluetooth Low Energy compatible devices, when it detected nearby devices that has the range of < 1 meter distance it triggered the alarm which would be outputted by the buzzer module and if the duration of scan reached 10 seconds, the data was stored in each devices would be uploaded to the database using PHP, that in return would send sql queries to MySQL database. Only authorized personnel can access the data that was stored in the database.

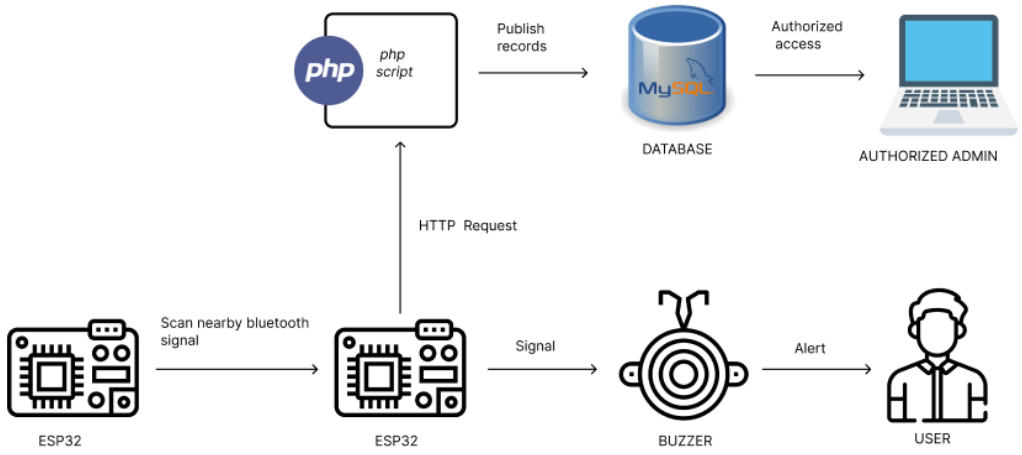


Figure 2. *System Architecture*

Database Design

Figure 3 illustrates the database design of the system. The students contact tracing records table stored the personal information of the students that violated

the 1 meter social distance which was projected in the value column and the time of contact was also shown in the created column.

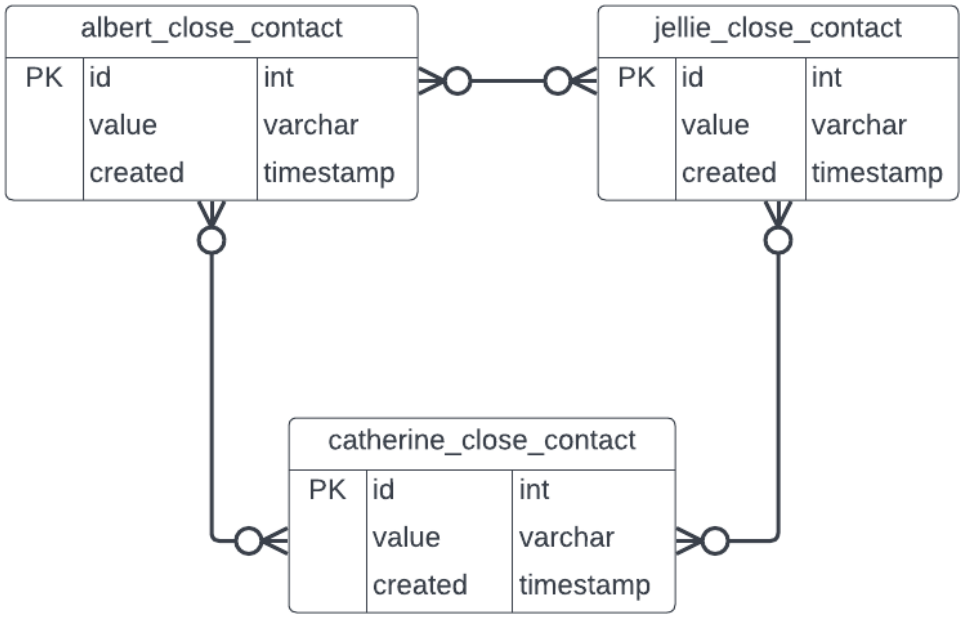


Figure 3. Entity Relationship Diagram of the System

Procedural and Object-Oriented Design

Figure 4 illustrates the procedural design of the system. It shows how the user interacts with the device and the corresponding actions to those interactions. The user carried the system (Recede) which when able to detect a similar system within 1 meter or less distance

the buzzer module would give an alert sound to the user. The duration of contact in seconds between users determined if they were a close contact or not. The personal information of the close contact user would be uploaded to the database for future reference.

The system utilized XAMPP local hosting which means that an individual that has access to the computer in which XAMPP was installed and hosted, also has access to the information of close contact individuals.

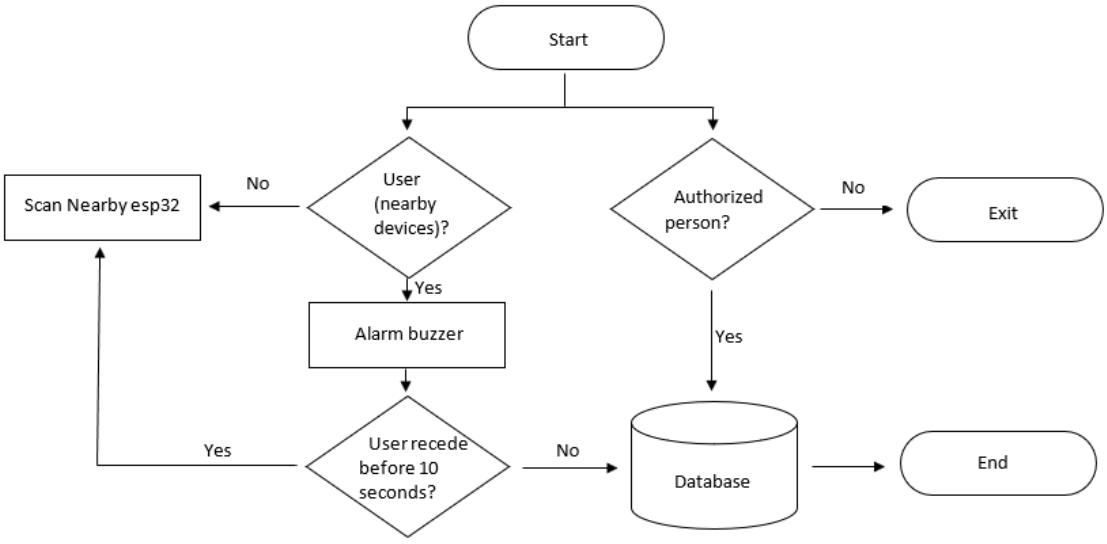


Figure 4. Procedural Design of the System

Figure 5 illustrates the object-oriented design of the system. It shows how the user has access to the

system in which it automatically scans and detects nearby devices and alerts the user whenever it picks up another system nearby and automatically uploads the personal information in the database based on the 10 second duration. The personal information that is stored in the database in which the authorized person can access for report generation of closed contact individuals.

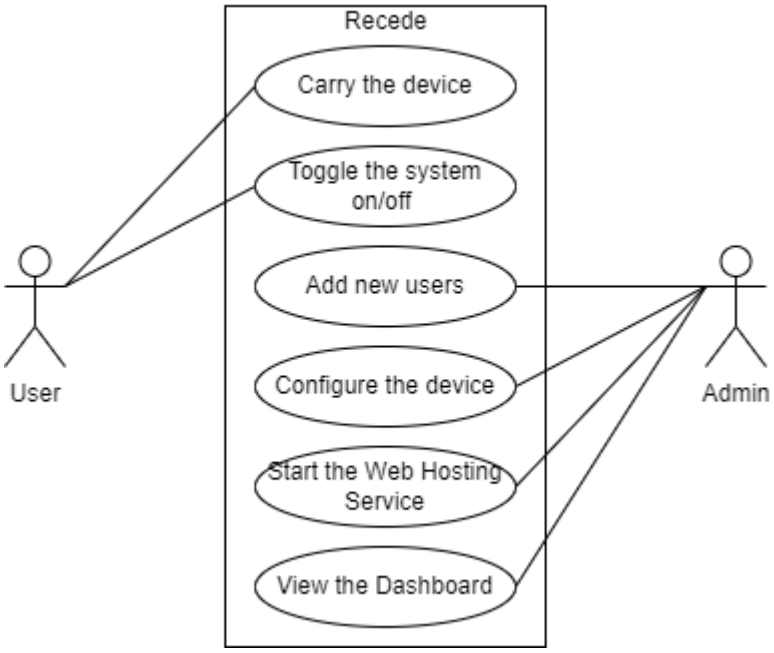
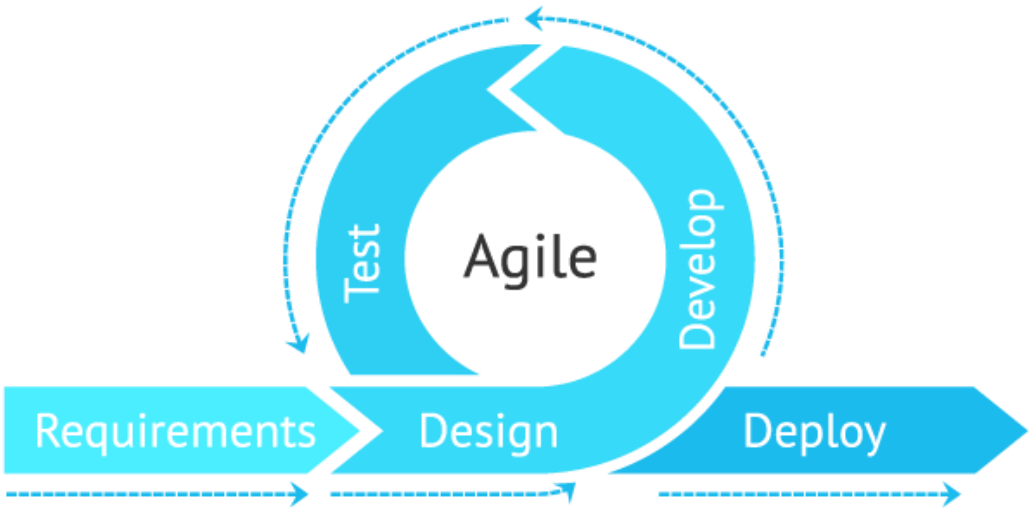


Figure 5. Use-case diagram

Methodology

System Development Life Cycle

The Agile Model of the Systems Development Life Cycle (SDLC) was used to develop the system. The phases that the researchers followed in this model were requirements, design, develop, test, and deployment. The system was able to go through several iterations with this model until it achieved the desired result for deployment.



Source:https://devcom.com/tech-blog/agile-advantages-for-business/

Figure 6. System Development Life Cycle Diagram

In the requirements phase, the researchers brainstormed to come up with the idea of Recede and identified the target population of the study which were the students of West Visayas State University. The researchers read and reviewed various researches on what hardware and software should be used in order to accomplish the goal. The researchers utilized Arduino IDE, PHP, XAMPP, APACHE and MySQL in developing the Recede.

In Design and Development, the researchers underwent several iterations from client-server connection to Peer-to-peer connection due to the nature of client/server in which it needs to establish connection thus multiple connection at once was not possible.

To ensure that the output alerts the participants and generates reports for contact tracing, the finished system was tested and repeatedly run during testing.

In Deployment, the finished system was subjected to ISO/IEC 25010- Software Product Quality Evaluation.

CHAPTER 4 RESULTS AND DISCUSSION

Implementation

Recede was implemented to provide a system that could help in the mitigation process of the spreading of the highly infectious and contagious disease, Covid-19. The system was developed to ensure that the physical distancing of the students, faculty and staff were strictly observed within the school premise.

The researchers utilized the ESP32 microcontroller, particularly, its Bluetooth Low Energy feature to measure the distance, and its Wi-Fi connectivity, to upload the data to the locally hosted database.

As shown on Figure 7, ESP32 Microcontroller was the main component of the device. It was used to program the device like configuring the threshold distance, configure each device with personal information that was reflected in the database that would be utilized for contact tracing measures, and assigned to which Wi-Fi it should be connected. Slide switch is used to turn on and off the Recede. In order for the hardware to operate, the researchers installed 3.7 volts with 1200mAh capacity

lithium-ion battery to power up the device. Micro USB Charging Module is connected to the lithium-ion battery to provide power if the battery runs out. Lastly, the system integrated a buzzer to communicate the warning signals to the users whenever they violated the 1 meter distance.

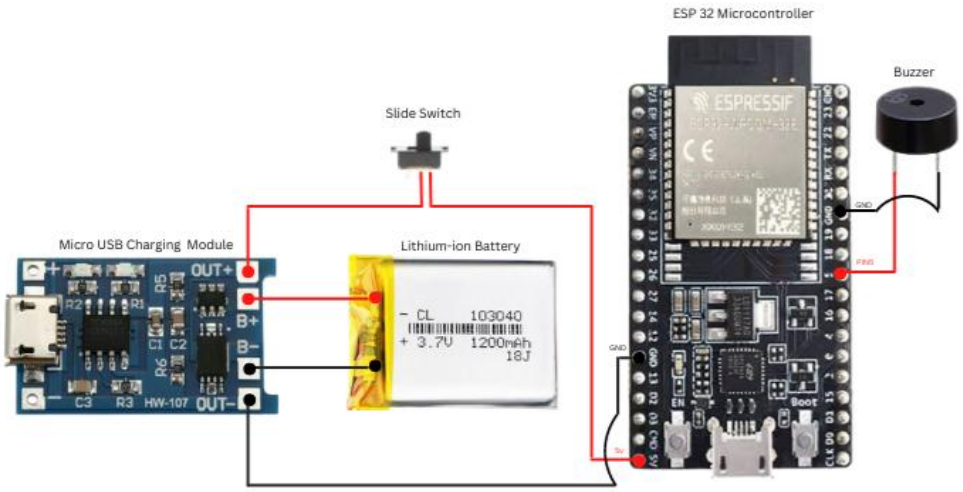


Figure 7. Schematic Diagram of the System

As shown on Figure 8, the device was packaged small enough to be carried in one's pocket or worn in their neck using a lanyard. Thus, this provides convenience to the bearer of the Recede. The researcher utilized a hard

plastic enclosure to put together and secure each component that made up the hardware of the system.

Figure 8. Prototype

The researchers utilized Arduino IDE and imported the appropriate board in the environment for the compatibility of the ESP32 microcontroller. The system was programmed to scan and upload data logs into the database.

The researchers implemented a unique identification mechanism between each microcontroller, in the form of service Universal Unique Identifier (UUIDs), as a means for a device to differentiate one from another, as opposed to identifying the devices just through their names. This method was used to avoid fraud in case an attacker might attempt to replicate the names of the

microcontrollers' bluetooth names. These service UUIDs were only specified in the ESP32 microcontrollers involved in the study. The UUIDs will also serve as the data-logging identifier if another microcontroller came in close contact with another microcontroller. Each UUID is associated with a specific microcontroller device, and that specific microcontroller device is also associated with a specific individual, where that individual's information was also stored. When logging the information, the logging device attempts to upload the close-contacted individual's contact tracing information based on the detected UUID.

The researchers set the RSSI value (Received Signal Strength Indicator) to -52 as it is closely comparable to 1 meter distance which will be the distance that should be maintained.

The duration of detection was also put into consideration as the researchers implemented a 10 second index that will be the amount of time before the devices will log close contact individual's personal information into the database. The data stored will be utilized as a means of contact tracing when someone acquired the COVID-

19 virus disease so that isolation would be performed immediately.

The acquired data from the scanning were immediately uploaded to the database through Internet connectivity into their respective tables after they are considered as close contact according to the 10 seconds index that will be used as a means of identifying close contact in case someone acquired the disease.

The implementation of the study was conducted at West Visayas State University - Main Campus. During testing, three students were equipped with Recede's hardware token. The testing was divided into two phases: the single interaction consisted of two participants, and the multiple interaction with three participants; both purposely violated the physical distancing. They carry these tokens the moment they step inside the campus. Throughout the day, the devices were carried inside the premises. At the end of the day, the devices were collected and stored by the safety officer, and will be distributed again to the same participants on the next day for fourteen (14) days consecutively.

As shown in figure 9, the dashboard presented the names of the participants that carried the hardware token of the system Recede. The admin can search through the provided search box to locate the intended participants that acquired the disease.

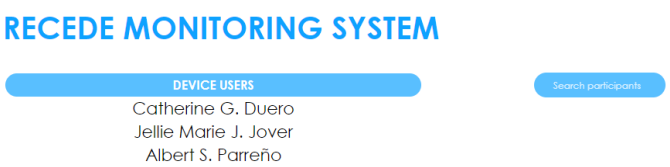


Figure 9. Dashboard

Figure 10 showed the dashboard of the participant that acquired the disease. The admin searched through the search box to filter through the close contacts time and date though this did not only limit the timestamp of the event but names were also be filtered through.

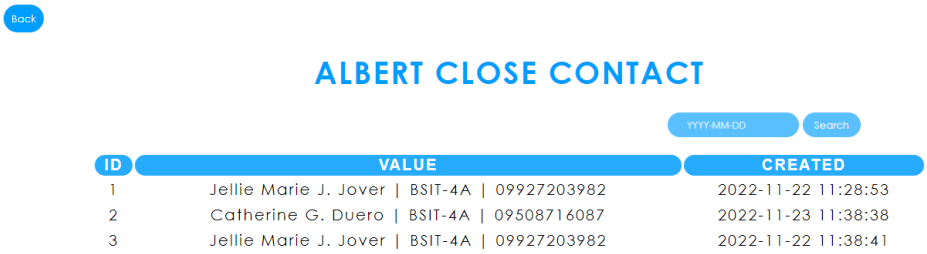


Figure 10. User Close Contact Logs Dashboard

Results Interpretation and Analysis

The study revealed that with the use of Recede, the system's integrated buzzer effectively emitted pulsing sound whenever the participants violated the 1 meter physical distancing and after 10 seconds of uninterrupted interaction it would emit continuous sound and the data were uploaded immediately into their respective table in the database. It will serve as a reference in the event of a participant contracting the Covid-19 virus.

Upon rigorous testing, the researchers discovered that there are a lot of factors affecting the performance of detection using bluetooth because it is prone to interference and performance degradation. There are a lot

of interference that affects the detection of bluetooth, one particular example is noise from other neighboring devices such as phones and radio towers because bluetooth works using radio transmission on a specific frequency and it is certain that the performance will degrade because other devices are snatching away the signal that the bluetooth needs in order to establish connection. Another limitation is performance degradation due to obstacles such as walls and the human body. These factors affect the detection and connection establishment of bluetooth because radio waves particularly 2.4ghz can technically penetrate walls but there will be depletion of signals that can affect the performance of detection. When the researchers presented their actual demo of a working prototype, they discovered that even if the participants wearing "Recede" attached to a lanyard and their back facing against each other the detection was not established.

Another limitation of the system is its wifi connectivity which is only limited to indoors due to the limitation of having a pre-configured wifi which translates to not being able to connect other access

points other than the configured one. Also, without an internet connection the system will not be able to upload the data of the closed contact individuals into the database but the detection and warning signals if someone violates the social distancing measures will continue to operate as intended.

As shown on figure 11, if their interaction has not reached 10 seconds for they have separated from each other during the scanning, the counting loop will reset and start all over again. “Recede count” counts the number of seconds that the respondents are close together, violating the 1-meter rule. “Recede away count” on the other hand counts the number of times, in seconds, that they are away. If the “Recede away count” reaches three (3) seconds within the ten (10) second time frame, the counting of the “Recede count” as well as the “Recede away count” will reset to zero (0).

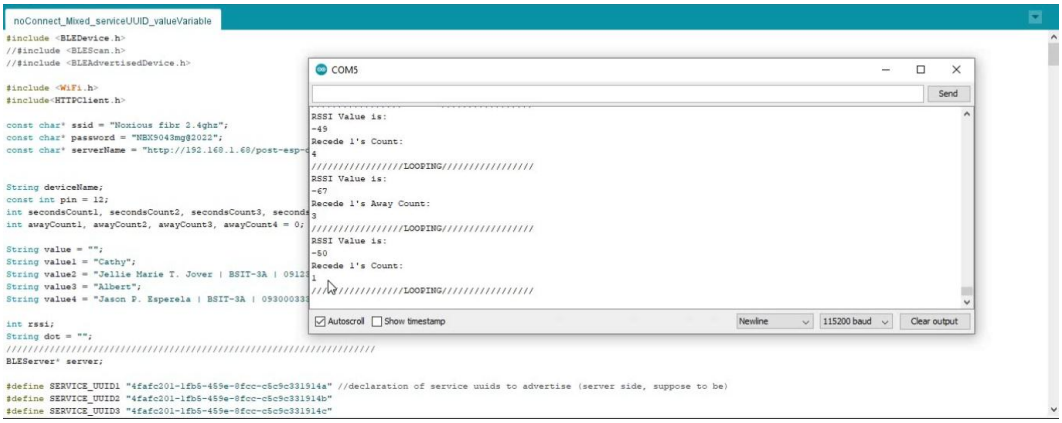


Figure 11. Resetting of the countdown to 1 second

As shown on Figure 12, the logging of data takes place whenever someone exposes for 10 seconds is instantaneous as long as there is internet connectivity, the device uploads the personal information right away as the counter reaches the 10 seconds' mark. Though the upload will be queued if multiple devices were detected but it is just a second difference.

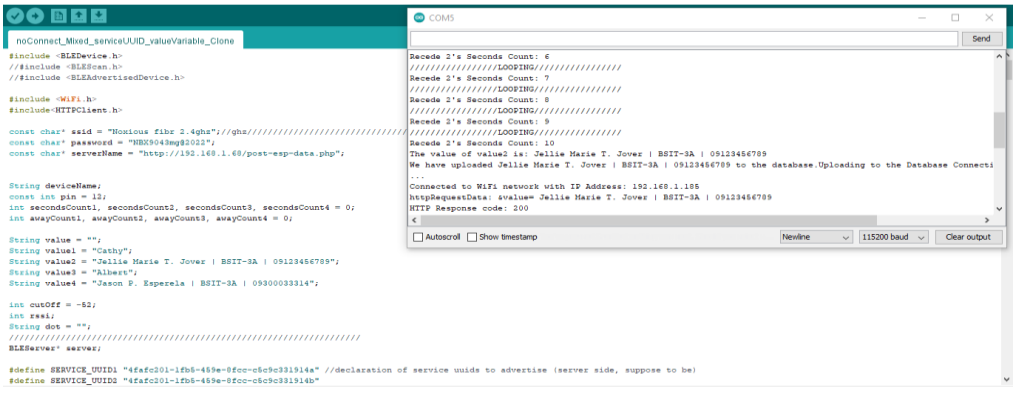


Figure 12. Logging of information in the database

As shown on Figure 13, if more than one user violated the physical distancing at the same time, the Recede can scan multiple devices and log two or more different information into their designated table; multiple information logs cannot upload simultaneously, rather it will queue one after the other.

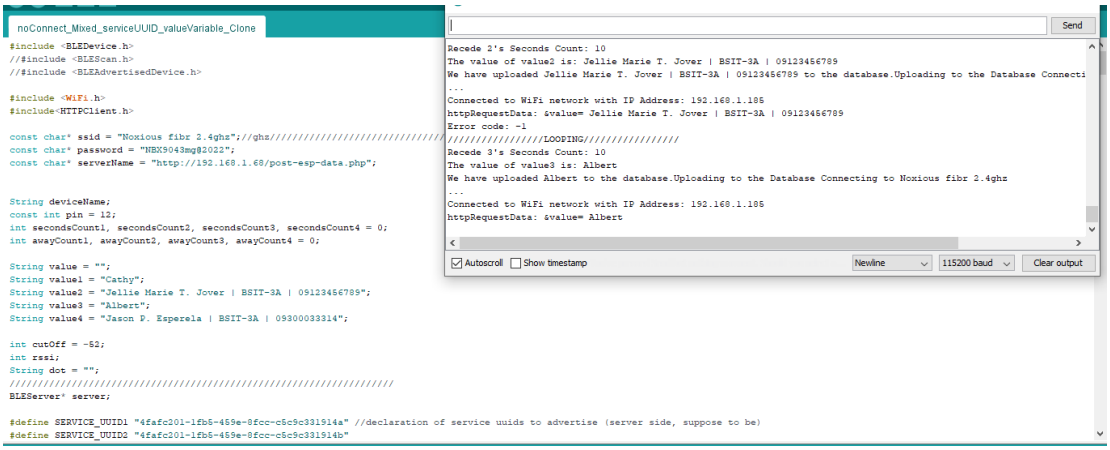


Figure 13. Multiple Interaction

As shown in figure 14, the information is saved with respect to the date and time stamp. The database of the system is handled by the authorized personnel only, to secure the information of the users. Every time the physical distancing is violated, the logging of information takes place between devices and stored the information on each designated table in the database.

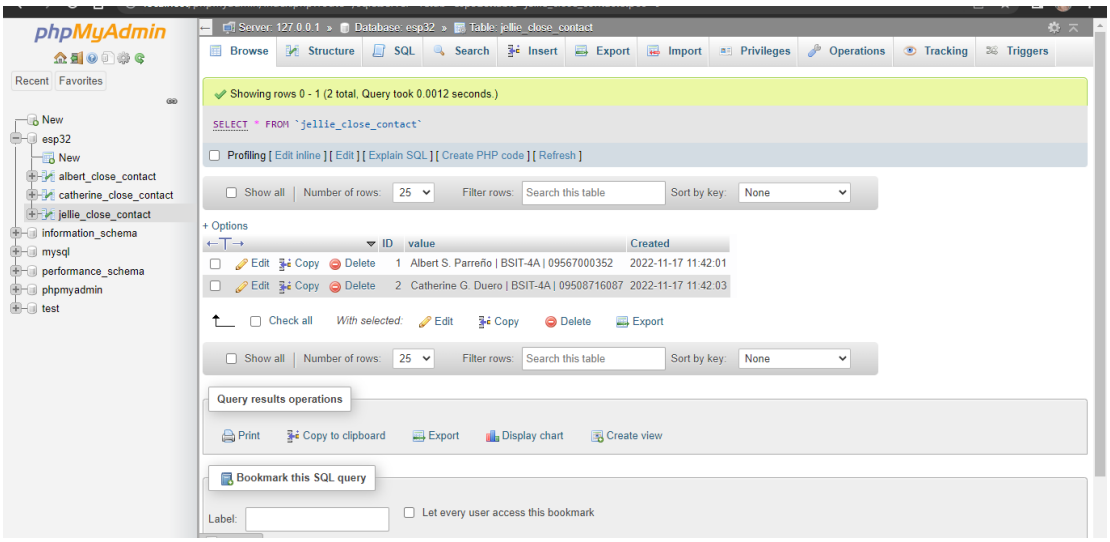


Figure 14. The Database Table

System Evaluation Results

To assess how well the system meets the system's stated and implied needs, the researchers used ISO/IEC 25010:2011.

The criteria for evaluation involved the following: Functional Suitability, Performance Efficiency, Compatibility, Usability, Reliability, Security, Maintainability, and Portability.

Also, the scores were interpreted using the five-point Likert's scale. A Likert scale is frequently utilized to evaluate changes in behavior as well as attitudes, knowledge, perceptions, and values. To rate the responses, they provide to evaluative questions, respondents may select from a list of statements on a Likert-type scale. It is composed of 31 questions to determine the quality of the system using a five-point scale: 5 as excellent (pass), 4 as very good (pass), 3 as satisfactory(pass), 2 as fair(fail), and 1 as poor(fail).

The respondents are composed of (4) IT experts, (3) Faculty/Staff, and (48) Students from different colleges.

Table 1

Scale used in Evaluation of the System

Scale	Description
1-1.80	Poor
1.81-2.60	Fair
2.61-3.40	Satisfactory
3.41-4.20	Very Good
4.21-5	Excellent

Table 2 shows the students' evaluation results of the system. Results showed that the functional suitability (M=4.16), performance efficiency (M=4.22), compatibility (4.44), usability (4.23), reliability (4.16), security (M=4.18), maintainability (M=4.30), portability (M=4.21), and the grand mean of 4.24, it resulted that the system shows excellent in terms of descriptive results.

Table 2

Students Evaluation Results of the System

Criteria	Mean	Description	Rank
Functional Suitability	4.16	Very Good	7.5

Performance Efficiency	4.22	Excellent	4
Compatibility	4.44	Excellent	1
Usability	4.23	Excellent	3
Reliability	4.16	Very Good	7.5
Security	4.18	Very Good	6
Maintainability	4.30	Excellent	2
Portability	4.21	Excellent	5
Grand Mean	4.24	Excellent	

Table 3 shows the system evaluation report for Faculty/Staff. Results showed that the Functional Suitability (M=3.33), Performance efficiency (M=4.56), compatibility (M=4.67), Usability (M=4), Reliability (M=4), Security (M=4), Maintainability (M=4), Portability (M=4), and Grand Mean of (M=4.07). The Grand mean interpreted the system as Very Good based on descriptive results.

Table 3

Faculty/Staff Evaluation Results of the System

Criteria	**Mean**	**Description**	**Rank**
Functional Suitability	3.33	Satisfactory	8

Performance Efficiency	4.56	Excellent	2
Compatibility	4.67	Excellent	1
Usability	4	Very Good	3
Reliability	4	Very Good	3
Security	4	Very Good	3
Maintainability	4	Very Good	3
Portability	4	Very Good	3
Grand Mean	**4.07**	**Very Good**	

Table 4 shows the evaluation results of IT experts. Results showed that Functional Suitability (M=4.17), Performance Efficiency (M=4.08), Compatibility (M=4.50), Usability (4.42), Reliability (4.19), Security (4.85), Maintainability (4.25), Portability (4.92), and with a Grand Mean (4.42). The Grand mean interpreted that the system is excellent in descriptive results.

Table 4

IT Experts Evaluation Results of the System

Criteria	Mean	Description	Rank
Functional Suitability	4.17	Very Good	7
Performance Efficiency	4.08	Very Good	8

Compatibility	4.50	Excellent	3
Usability	4.42	Excellent	4
Reliability	4.19	Very Good	6
Security	4.85	Excellent	2
Maintainability	4.25	Excellent	5
Portability	4.92	Excellent	1
Grand Mean	**4.42**	**Excellent**	

Table 5 shows the Overall Evaluation result of Students, IT experts, and Faculty/Staff. The results showed Functional Suitability (M=3.70), Performance Efficiency (M=3.79), Compatibility (M=4.01), Usability (M=3.79), Reliability (M=3.71), Security (M=3.78), Maintainability (M=3.82), Portability (M=3.80), and Grand Mean of (M=3.80). The Grand Mean interpreted the system as Very Good based on the descriptive results.

Table 5

Students, Faculty/Staff, IT Experts Evaluation Results of the System

Criteria	Mean	Description	Rank
Functional Suitability	3.70	Very Good	8

Performance Efficiency	3.79	Very Good	4.5
Compatibility	4.01	Very Good	1
Usability	3.79	Very Good	4.5
Reliability	3.71	Very Good	7
Security	3.78	Very Good	6
Maintainability	3.82	Very Good	2
Portability	3.80	Very Good	3
Grand Mean	**3.80**	**Very Good**	

CHAPTER 5 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary of the Proposed Study and Design Implementation

The researchers developed a system entitled, "Recede: A Social Distancing System Using ESP32 Microcontroller and Bluetooth Low Energy for Peer-to-Peer Warning Signal." This proposed system was developed to help in mitigating the spread of CoronaVirus Disease (COVID-19) inside the school grounds. The system is composed of a buzzer, a microcontroller, charging module, battery, a locally hosted database and a dashboard. The Bluetooth Low Energy feature of the Microcontroller was used to scan nearby "Recede" devices, while its Wi-Fi feature enables the system to access the internet and upload the data exchange of each "Recede" to their own respective databases hosted locally. The buzzer allows the system to communicate the warning signal to the users, a pulsing sound will emit if the users violated the one (1) meter distance while counting the exposure time of the violators. If the exposure reaches ten (10) seconds, the buzzer emits a continuous sound that signifies that the information of the violators was

uploaded to the database. They then have become a close-contact person and are subject to contact tracing if one of them is included in the list of the person that acquired the disease.

The software functionality of each device was developed through the use of Arduino IDE. The researchers imported the appropriate board in the IDE environment for the compatibility of the ESP32 Microcontroller's system.

The system was designed to be a wearable device for the users. It could be worn like a necklace, as a bracelet or as a keychain and was carried during the testing phase inside the premises.

The system was demonstrated by the researchers and evaluated by forty-eight (48) students, three (3) faculties or staff, and four (4) IT experts.

Summary of Findings

Based on the results of the evaluation, the system effectively scans and reads information and records it to their respective database table and reflects the logs in realtime through a dashboard. From the students'

evaluation results, the grand mean is 4.24, which translates to excellent. From the faculty and staff, the grand mean is 4.07, which translates to very good. From the IT experts, the grand mean is 4.42, which translates to excellent. The evaluation yielded an overall grand mean of 3.80, which interprets as very good based on the criteria. The proposed system passed the ISO 25010 Software Product Quality Standards with a mean of 3.80 which is equivalent to Very Good based on the Likert scale. The system “Recede” is feasible and effective, and can be used as an instrument for physical distancing and contact tracing.

Conclusions

From the aforementioned findings, the following conclusions were drawn.

1. The system was able to successfully utilize the Bluetooth Low Energy feature of the ESP32 Microcontroller to scan nearby ESP32.
2. The system was able to implement the buzzer to communicate the warning prompt, signaling the users

to maintain a safe distance of 1 meter. The range of the scanning was measured using RSSI value -52 which is equivalent to 1 meter according to rigorous testing. The 10 second rule was adopted before individuals are considered as closed contact and the system can log the exchange data of each device before it uploads it to their respective databases.

3. The system was able to create a safe space for the data logs of each individual device utilizing the capacity of XAMPP, particularly the Apache web server and MySQL database that can locally and safely host the database that can only be accessed by the person in authority using the provided dashboard, adding to that is the capability of the ESP32 to provide wifi connectivity that enables the upload of data logs wirelessly.
4. The system was evaluated by three entities: students, faculty/staff, and IT Expert. Based on the mean scale of; 1-1.80 being poor, 1.81-2.60 being fair, 2.61-3.40 being satisfactory, 3.41-4.20 being very good, and 4.21-5 being excellent, the system placed at 3.80 which is equivalent to the

description very good. This means that the system passed the ISO standards evaluation with a considerably high rating.

Recommendations

Based on the findings of the study, the following recommendations were suggested:

1. The system should be able to hold and store data in the device if there is network interruption and whenever the connection is available it will immediately upload the data with respect to the timestamp of the actual time of the physical distancing violation.
2. The system should reduce the seconds delay before scanning other systems to increase accuracy since it has 2 to 3 seconds delay before recognizing nearby systems and the 10 seconds index for interaction might not be implemented strictly.
3. The system's hardware container should be stylish and comfortable because users will wear it the moment they step inside the school grounds all day.

4. Based on the overall results of the evaluation, the system has to improve its functional suitability and reliability the most.

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Appendices

Appendix A

Letter to the Adviser

February 4, 2022

SANSOLIS, EVANS B.

Instructor I

Dear Dr. Evans B. Sansolis,

The undersigned are BS Information Technology Research 1/Thesis 1 students of CICT, this university. Our thesis/capstone project title is *"Recede: A Social Distancing System using ESP32 Microcontroller and Bluetooth Low Energy for Peer-to-Peer Warning Signal".*

Knowing of your expertise in research and on the subject matter, we would like to request you to be our ADVISER.

We are positively hoping for your acceptance. Kindly check the corresponding box and affix your signature in the space provided. Thank you very much.

Respectfully yours,

1. Catherine G. Duero
2. Jason P. Esperela
3. John Ray T. Godin
4. Jellie Marie J. Jover
5. Albert S. Parreño

PS:

Advisers are tasked to work with the students in providing direction and assistance as needed in their thesis/capstone project. They shall meet with the students weekly or as needed to provide direction, check on progress and assist in resolving problems until such a time that the students pass their defenses and submit their final requirements, as well as, preparing their evaluations and grades.

CC:

CICT Dean

Research Coordinator Group

Appendix B
Letter to the Technical Editor

	ADVISER'S ENDORSEMENT FORM (For Thesis Manuscript)	Document No.	WVSU-ICT-SOI-03-F10
		Issue No.	1
		Revision No.	0
	WEST VISAYAS STATE UNIVERSITY	Date of Effectivity:	April 27, 2018
		Issued by:	CICT
		Page No.	Page 1 of 1

Respectfully endorsed to the **Technical Editor**, the attached manuscript of the thesis entitled:

Recede: A Social Distancing System Using ESP32 Microcontroller and Bluetooth Low Energy for Peer-to-Peer Warning Signal.

Said manuscript has been presented to me for preliminary evaluation and guidance, and after a series of corrections/directions given which was implemented by the proponents whose names are listed hereunder and their thorough research, we have come to its completion.

Now therefore, I hereby **ENDORSE** the said thesis manuscript to the Technical Editor for **TECHNICAL EDITING**.

Dr. Evans B. Sansolis
Adviser's Name & Signature

Date: May 5, 2023

Group Members:
1. Duero, Catherine G.
2. Esperela, Jason P.
3. Godin, John Ray T.
4. Jover, Jellie Marie J.
5. Parreño, Albert S.

Note: *This form should be accomplished and signed if the corrections and changes made by the adviser have been implemented and a new copy of the document have been printed for checking and submission to the next editor*

Appendix C

Letter to the English Editor

	TECHNICAL EDITOR'S ENDORSEMENT FORM (For Thesis Manuscript)	Document No.	WVSU-ICT-SOI-03-F11
		Issue No.	1
		Revision No.	0
	WEST VISAYAS STATE UNIVERSITY	Date of Effectivity:	April 27, 2018
		Issued by:	CICT
		Page No.	Page 1 of 1

Respectfully endorsed to the **English Editor**, the attached manuscript of the thesis entitled:

Recede: A Social Distancing System using ESP32 Microcontroller and Bluetooth Low Energy for Peer-to-Peer Warning Signal

Said manuscript was presented to me and was reviewed and edited in terms of technical specifications, correctness of diagrams and other technical matters. The corrections and suggestions was carried and implemented by the proponents whose names are listed hereunder.

Now therefore, I hereby **ENDORSE** the said thesis manuscript to the English Editor/Grammarian for **English Grammar Editing.**

Dr. Ma. Beth S. Concepcion
Technical Editor's Name & Signature

Date: May 19, 2023

Group Members:
1. Duero, Catherine G.
2. Esperela, Jason P.
3. Godin, John Ray T.
4. Jover, Jellie Marie J.
5. Parreño, Albert S.

Note: *This form should be accomplished and signed if the corrections and changes made by the Technical Editor have been implemented and a new copy of the document have been printed for checking and submission to the next editor.*

Appendix D

Letter to the Format Editor

	ENGLISH EDITOR/GRAMMARIAN'S ENDORSEMENT FORM (For Thesis Manuscript)	Document No.	WVSU-ICT-SOI-03-F12
		Issue No.	1
		Revision No.	0
	WEST VISAYAS STATE UNIVERSITY	Date of Effectivity:	April 27, 2018
		Issued by:	CICT
		Page No.	Page 1 of 1

Respectfully endorsed to the **Thesis Format Editor**, the attached manuscript of the thesis entitled:

Recede: A Social Distancing System using ESP32 Microcontroller and Bluetooth Low Energy for Peer-to-Peer Warning Signal

Said manuscript was presented to me for English grammar editing, corrections has been made and the proponents whose names are listed hereunder implemented said corrections and changes in the revised manuscript.

Now therefore, I hereby **ENDORSE** the said thesis manuscript for **Thesis Format Editing**.

Prof. Marievic Violeta, MAEd

English Editor/Grammarian's Name and Signature

Date: May 24, 2023

Group Members:
1. Duero, Catherine G.
2. Esperela, Jason P.
3. Godin, John Ray T.
4. Jover, Jellie Marie J.
5. Parreño, Albert S.

Note: *This form should be accomplished and signed if the corrections and changes made by the English Editor have been implemented and a new copy of the document have been printed for checking and submission to the next editor.*

Appendix E

Letter to the Thesis Coordinator

	THESIS FORMAT EDITOR'S ENDORSEMENT FORM (For Thesis Manuscript)	Document No.	WVSU-ICT-SOI-03-F13
		Issue No.	1
		Revision No.	0
	WEST VISAYAS STATE UNIVERSITY	Date of Effectivity:	April 27, 2018
		Issued by:	CICT
		Page No.	Page 1 of 1

Respectfully endorsed to the **Thesis Coordinator**, the attached manuscript of the thesis entitled:

Recede: A Social Distancing System Using ESP32 Microcontroller and Bluetooth Low Energy for Peer-to-Peer Warning Signal

Said manuscript was presented to me and has checked the preliminaries, thesis document convention and end matters, made some corrections which was implemented by the proponents whose names are listed hereunder.

Now therefore, I hereby **ENDORSE** said manuscript to the Thesis Coordinator for appropriate action.

Dr. Regin A. Cabacas
Thesis Format Editor's Name and Signature

Date: May 30, 2023

Group Members:
1. Duero, Catherine
2. Esperela, Jason P.
3. Godin, John Ray T.
4. Jover, Jellie Marie J.
5. Parreño, Albert S.

Note: *This form should be accomplished and signed if the corrections and changes made by the Thesis Format Editor have been implemented and the four (4) new copies have been printed ready for bookbinding.*

Appendix F

Letter for Bookbinding

	CERTIFICATION FOR BOOKBINDING (For Thesis Manuscript)	Document No.	WVSU-ICT-SOI-03-F14
		Issue No.	1
		Revision No.	0
	WEST VISAYAS STATE UNIVERSITY	Date of Effectivity:	April 27, 2018
		Issued by:	CICT
		Page No.	Page 1 of 1

This certifies that the attached manuscript of the thesis entitled:

Recede: A Social Distancing System using ESP32 Microcontroller and Bluetooth Low Energy for Peer-to-Peer Warning Signal

Is now ready for bookbinding. Said manuscript was presented to me and has checked the preliminaries, thesis document convention and end matters, made some corrections which was implemented by the proponents whose names are listed hereunder.

Now therefore, I hereby **ENDORSE** said manuscript for **BOOKBINDING**.

Dr. Regin A. Cabacas
Thesis Coordinator's Name and Signature

Date: May 30, 2023

Group Members:
1. Duero, Catherine G.
2. Esperela, Jason P.
3. Godin, John Ray T.
4. Jover, Jellie Marie J.
5. Parreño, Albert S.

Note: *This form should be accomplished and signed if the corrections and changes made by the Thesis Format Editor have been implemented and the four (4) new copies have been printed ready for bookbinding.*

Appendix G

Gantt Chart

GANTT CHART	Duration											
TASK	2022											
	January	February	March	April	May	June	July	August	September	October	November	December
20% Thesis Defense												
50% Thesis Defense												
Final Thesis Defense												
CHAPTER 1												
Background of the Study												
Theoretical Framework												
Objectives of the Study												
Significance of the Study												
Definition of Terms												
Delimitations of the Study												
CHAPTER 2												
Review of Existing and Related Studies												
CHAPTER 3												
Description of the Proposed Study												
Methods and Proposed Enhancements												
Components and Design												
System Architecture												
Database Design												
Procedural Design												
Object-Oriented Design												
Process Design												
System Development Life Cycle												
CHAPTER 4												
Implementation												
Results Interpretations and Analysis												
System Evaluation and Results												
CHAPTER 5												
Summary of the Proposed Study Design and Implementation												
Summary of Findings												
Conclusions												

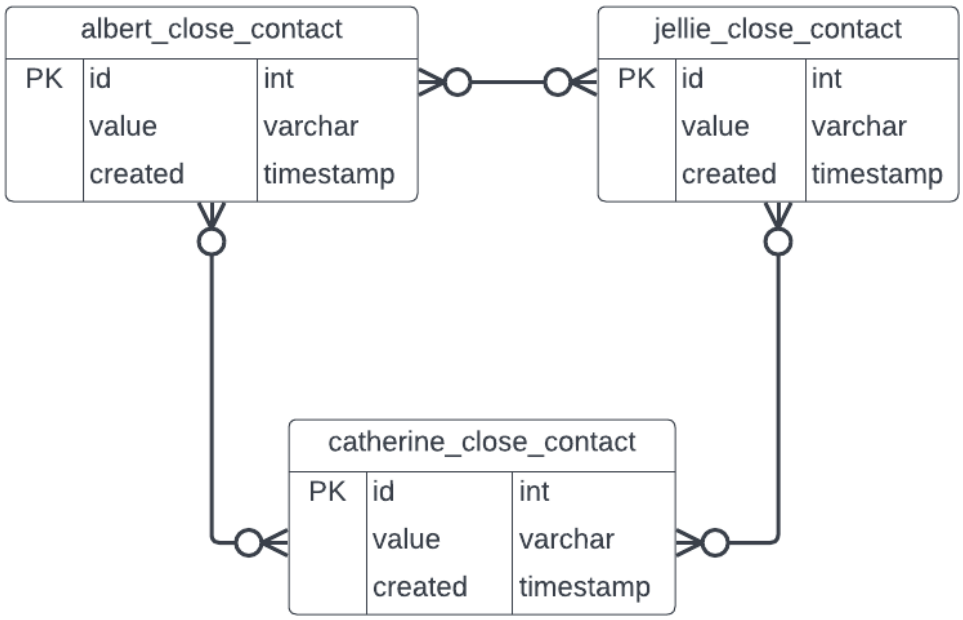
Appendix H

Production Cost Estimate

Product	**Cost**
ESP32 WROOM 32D	₱195.00
Buzzer	₱60.00
Jumper wires	₱10.00
Lithium-ion Battery	₱190.00
Micro USB Charging Module	₱20.00
Slide Switch	₱35.00
Hard Plastic Enclosure	₱35.00
Lanyard	₱15.00
TOTAL	₱560.00

Appendix I

Entity Relationship Diagram



Appendix J

Sample Program Codes

Recede Dashboard for Monitoring

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="utf-8">
    <meta name="viewport" content="width=device-width,
initial-scale=1">
    <title>Dashboard</title>
    <link rel="stylesheet" type="text/css"
href="dashboardver2style.css" media="screen">
  </head>
  <body>
    <h2>RECEDE MONITORING SYSTEM</h2>
    <input type="text" id="myInput" class="search"
onkeyup="myFunction()" placeholder="Search participants">
    <div class="container">

        <table id="myTable" cellspacing="1"
cellpadding="1">
```

```
            <tr class="header">
                 <th class="databases">DEVICE USERS</th>
            </tr>
            <tr>
                <td><a class="hovers"
href="cathy_close_contact.php">Catherine G.
Duero</a></td>
            </tr>
            <tr>
                <td><a class="hovers"
href="jhellay_close_contact.php">Jellie Marie J.
Jover</a></td>
            </tr>
            <tr>
                <td><a class="hovers"
href="albert_close_contact.php">Albert S.
Parreño</a></td>
            </tr>
            <!-- <tr>
                <td>Jason P. Esperela</td>
            </tr>
            <tr>
```

```
                <td>John Ray T. Godin</td>
            </tr> -->
        </table>
    </div>
    <script>
        function myFunction(){
        var input, filter, table, tr, td, i, txtValue;
        input = document.getElementById("myInput");
        filter = input.value.toUpperCase();
        table = document.getElementById("myTable");
        tr = table.getElementsByTagName("tr");

        for (i = 0; i < tr.length; i++){
            td = tr[i].getElementsByTagName("td")[0];
            if (td){
                txtValue = td.textContent ||
td.innerText;
                if (txtValue.toUpperCase().
indexOf(filter) > -1){
                    tr[i].style.display = "";
                }
                else{
```

```
                    tr[i].style.display = "none";
                }
            }
        }
        }
    </script>
  </body>
</html>
```

Recede User's Close Contact List Page

```
<!DOCTYPE html>
<html>
<head>
     <meta http-equiv="refresh" content="5" charset="utf-
8">
     <link rel="stylesheet" type="text/css"
href="albert_close_contactstyle.css" media="screen">
     <title>Recede database</title>
</head>
<body>
```

```
          <button class="back" id="myInput"
onkeyup="myFunction()"><a
href="dashboardver2.php">Back</a></button>
          <h1>ALBERT CLOSE CONTACT</h1>


<?php
include 'search.php';
$servername = "localhost";
$username = "root";
$password = "secret";
$dbname  = "esp32";

$conn = new mysqli($servername, $username, $password,
$dbname);
if ($conn->connect_error){
     die("Connection failed: " .$conn->connect_error);
}
$sql = "SELECT id, value, created FROM
albert_close_contact ";

if ($result = $conn->query($sql)){
     while($row = $result->fetch_assoc()){
```

```
            $row_id = $row["id"];
            $row_value = $row["value"];
            $row_created = $row["created"];

            // echo '<tr>
            //   <th>' . $row_id . ' </th>
            //   <th>' . $row_value . '</th>
            //   <th>' . $row_created . '</th><br>
            // </tr>';
        }
        $result->free();
}
$conn->close();
?>
</body>
</html>
```

Main code for ESP32 Microcontroller

```
#include <BLEDevice.h>
```

```
#include <WiFi.h>

#include<HTTPClient.h>


const char* ssid = "Recede";

const char* password = "09870987";

const char* serverName =

"http://192.168.30.57/albert.php";


//"http://192.168.30.57/jellie.php";

//"http://192.168.30.57/catherine.php"; //


String deviceName;

const int pin = 5;

int secondsCount1, secondsCount2, secondsCount3 = 0;

int awayCount1, awayCount2, awayCount3 = 0;


String value = "";

String value1 = "Catherine G. Duero | BSIT-4A |

09508716087";

String value2 = "Jellie Marie J. Jover | BSIT-4A |

09927203982";
```

```
String value3 = "Albert S. Parreño | BSIT-4A |
09567000352";


int cutOff = -52;
int rssi;
String dot = "";
//////////////////////////////////////////////////////
BLEServer* server;


#define SERVICE_UUID1 "4fafc201-1fb5-459e-8fcc-
c5c9c331914a" //declaration of service uuids to advertise
(server side, suppose to be)
#define SERVICE_UUID2 "4fafc201-1fb5-459e-8fcc-
c5c9c331914b"
#define SERVICE_UUID3 "4fafc201-1fb5-459e-8fcc-
c5c9c331914c"
//////////////////////////////////////////////////////
BLEUUID serviceUUID1("4fafc201-1fb5-459e-8fcc-
c5c9c331914a"); //declaration of known service uuids to
scan (client side, suppose to be)
BLEUUID serviceUUID2("4fafc201-1fb5-459e-8fcc-
c5c9c331914b");
```

```
BLEUUID serviceUUID3("4fafc201-1fb5-459e-8fcc-
c5c9c331914c");


BLEScan* scan;
BLEClient* pClient;


BLEAdvertisedDevice device;
void setup() {
  Serial.begin(115200);
  pinMode(pin,OUTPUT);
  Serial.println("Scanning...");
  BLEDevice::init("Recede3");       //Per ESP, we change
the .php file, BLE advertising name,and the advertised
UUID


  server = BLEDevice::createServer();
  BLEAdvertising* advertising =
BLEDevice::getAdvertising();
  advertising->addServiceUUID(SERVICE_UUID3);
  BLEDevice::startAdvertising();
}
void loop() {
```

```
  scan = BLEDevice::getScan();
  scan->setActiveScan(true);
  BLEScanResults results = scan->start(1);


  for(int i = 0; i < results.getCount(); i = i + 1){
    device = results.getDevice(i);
    rssi = device.getRSSI();
    /*Serial.println("RSSI Value is: ");
    Serial.println(rssi);*/
    deviceName = (device.getName().c_str());
////////////////////////////////////////////////
      if(device.isAdvertisingService(serviceUUID1) &&
rssi > cutOff){
        digitalWrite(pin,HIGH);
        delay(500); //Delay between loops
        secondsCount1 = secondsCount1 + 1;
        Serial.print("Recede 1's Count: ");
        Serial.println(secondsCount1);
        if(secondsCount1 == 10){
          Serial.print("The value of value1 is: ");
          Serial.println(value1);
```

```
          //if (value1 != ""){
            Serial.print("We have uploaded ");
            Serial.print(value1);
            Serial.print(" to the database.");

            Serial.print("Uploading to the Database" );
            WiFi.begin(ssid, password);
            Serial.print("Connecting to " );
            Serial.println(ssid);

            while(WiFi.status() != WL_CONNECTED){
              delay(1000);
              Serial.print(dot);
              dot = dot + ".";

              if(dot == "....."){
                Serial.print("/////////RESTARTING
WIFI/////////");
                Serial.print("Uploading to the Database "
);
                WiFi.begin(ssid, password);
```

```
                Serial.print("Connecting to " );
                Serial.println(ssid);
                dot = "";
              }
            }//while
                Serial.println("");
                Serial.print("Connected to WiFi network
with IP Address: ");
                Serial.println(WiFi.localIP());
                if(WiFi.status()== WL_CONNECTED){
                  HTTPClient http;
                  http.begin(serverName);
                  http.addHeader("Content-Type",
"application/x-www-form-urlencoded");
                  value = value1;
                  String httpRequestData =  "&value= " +
value;
                  Serial.print("httpRequestData: ");
                  Serial.println(httpRequestData);

                  int httpResponseCode =
http.POST(httpRequestData);
```

```
      if (httpResponseCode > 0){
        Serial.print("HTTP Response code: ");
        Serial.println(httpResponseCode);
      }
      else{
        Serial.print("Error code: ");
        Serial.println(httpResponseCode);
      }
      http.end();

    }//wifi status
    else{
      Serial.println("WiFi Disconnected");
    }
    WiFi.disconnect();
    dot = "";
    value = "";
    awayCount1 = 0;
    secondsCount1 = 0;
  //}//if value
}//secondscount
```

```
        if(secondsCount1 > 10){
          secondsCount1 = 10;//if the countdown exceeds
10, return count to 9
        }
      }// if device name && rssi > cutOff

      if(device.isAdvertisingService(serviceUUID1) &&
rssi < cutOff){
        digitalWrite(pin,LOW);
        delay(500); //Delay between loops
        awayCount1 = awayCount1 + 1;
        Serial.print("Recede 1's Away Count: ");
        Serial.println(awayCount1);
          if(awayCount1 == 3){//3 seconds of being away
            secondsCount1 = 0;
            awayCount1 = 0;

          }
      }// if device name && rssi < cutOff
      else{
        digitalWrite(pin,LOW);
      }// else
```

Appendix K

ISO 25010 Software Evaluation Instrument

I. Software: _____

Name of Juror: _____

Position/Designation: _____

II. Instructions. Please rate the following statements by putting a checkmark on how much you agree or disagree.

1 – Poor
2 – Fair
3 – Satisfactory
4 – Very good
5 - Excellent

	1	2	3	4	5
A. Functional Stability					
1. Functional completeness. The system covers all the specified tasks and user objectives.					
2. Functional correctness. The system provides the correct results with the needed degree of precision.					

3. Functional appropriateness. The system facilitates the accomplishment of specified tasks and objectives.					
B. Performance Efficiency					
1. Time behavior. The system response and processing times perform its functions and meet requirements.					
2. Resource utilization. The system amounts and types of resources perform its functions and meet requirements. 3. Capacity. The system has the maximum limits/capacity that meet requirements.					
C. Compatibility					
1. Co-existence. The system can perform its required functions efficiently while sharing a common environment and resources with other products, without detrimental impact on any other product.					
2.Interoperability. Two or more system					

components can exchange information and use the information and use the information that has been exchanged.					
D. Usability					
1. Appropriateness recognizability. The users can recognize whether the system is appropriate to their needs.					
2. Learnability. The system can be used by specified users to achieve the specified goals of learning with effectiveness, efficiency, freedom from risk and satisfaction in a specified context of use.					
3.Operability. The system has attributes that makes it easy to operate and to control.					
4.User error protection. The system protects users against making errors.					
5.User interface aesthetics. The system has a user interface that enables pleasing and					

satisfying interaction for the user.					
6. Accessibility. The system can be used by people with the widest range of characteristics and capabilities to achieve a specified goal in a specified context of use.					
E. Reliability					
1.Maturity. The system meets needs for reliability under normal operation.					
2. Availability. The system is operational and accessible when required for use.					
3. Fault tolerance. The system operates as intended despite the presence of hardware or software faults.					
4. Recoverability. The system can recover the data directly affected and re-establish the desired state of the system in the event of an interruption or a failure.					

F. Security					
1. Confidentiality. The system ensures that data are accessible only to those authorized to have access.					
2. Integrity. The system prevents unauthorized access to, or modification of, computer programs or data.					
3. Non-repudiation. Actions or events can be proven to have taken place so that the events or actions cannot be repudiated later in the system.					
4. Accountability. The actions of an entity can be traced uniquely to the entity in the system.					
5. Authenticity. The identity of a subject or resource can be proved to be the one claimed in the system.					

G. Maintainability					
1. Modularity. The system is composed of discrete components such that a change to one component has minimal impact on other components.					
2. Reusability. A system asset can be used in more than one system, or in building other assets.					
3. Analyzability. The system is effective and efficient with which it is possible to assess the impact on a product or system of an intended change to one or more of its parts, or to diagnose a product for deficiencies or causes of failures, or to identify parts to be modified.					
4. Modifiability. The system can be effectively and efficiently modified without introducing defects or degrading existing product quality.					

5. Testability. The system is effective and efficient with which test criteria can be established for a system, product or component and tests can be performed to determine whether those criteria have been met.					
H. Portability					
1. Adaptability. The system can effectively and efficiently be adapted for different or evolving hardware, software or other operational or usage environments.					
2. Installability. The system is effective and efficient with which a system can be successfully installed and/or uninstalled in a specified environment.					
3. Replaceability. The system can replace another specified software for the same purpose in the same environment.					

Appendix L

Disclaimer

This software project and its corresponding documentation titled "*Recede: A Social Distancing System using ESP32 Microcontroller and Bluetooth for Peer to Peer Warning Signal*" is submitted to the College of Information and Communications Technology, West Visayas State University, in partial fulfillment of the requirements for the degree, Bachelor of Science in Information Technology. It is the product of our own work, except where indicated text.

We hereby grant the College of Information and Communications Technology permission to freely use, publish in local or international journal/conferences, reproduce, or distribute publicly the paper and electronic copies of this software project and its corresponding documentation in whole or in part, provided that we are acknowledged.

Catherine G. Duero Jason P. Esperela John Ray T. Godin

Jellie Marie J. Jover Albert S.Parreño

June 2023