RIZAL TECHNOLOGICAL UNIVERSITY

College of Engineering, and Architecture
Boni Avenue, Mandaluyong City

DEVELOPMENT OF AN ALARM SYSTEM USING LORAWAN TECHNOLOGY

A Capstone Project Presented to the Department of Electronics Engineering
College of Engineering and Architecture
Rizal Technological University
Mandaluyong City

In Partial Fulfillment of the Requirements for the
Bachelor of Science in Electronics Engineering

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April 2024

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ACKNOWLEDGEMENT

The researchers would like to take this opportunity to extend their deepest appreciation to everyone who helped them during the research study.

First and foremost, they would want to thank our Almighty God for leading them and allowing them to complete this project with exceptional diligence and understanding.

They also wanted to convey their appreciation to Engr. Julius Ferrer Mabanglo, a member of the faculty and professor of the Electronics Engineering Department, was also their research adviser, for his significant advice and support in making this project feasible.

Dr. Wilfredo Timajo, topic adviser for researcher's Capstone 1 and 2, in providing lectures and resources that have a significant impact on the researcher's studies.

To our Panelists, Engr. Jaime P. Licuanan, Engr. RS L. Lagrimas, Engr. Darius Trance, Engr. Mark Jommel S. Nasol, Inst. Jayros V. Amar, Mr. Jeffrey Aquino and Engr. Renzbenhar Bobadilla for their assistance and clarifying comments, as well as additional suggestions that enabled the researchers to complete the colloquium and final defense.

DEDICATION

This research project is dedicated to our parents, who have always been an eternal source of inspiration and support for us. Their love, advice, and sacrifices have been the driving forces behind our academic path, and we will be eternally thankful. Their strong faith in us has been a constant source of inspiration and motivation for us, and we hope this thesis serves as proof of your unwavering support for us.

Finally, we dedicate this research to the Almighty, who provides us with courage, decision-making, guidance, intellectual capacity, protection, knowledge, and good health as we go on with this study.

ABSTRACT

During natural disasters, today's community relies on various communication technologies to communicate with one another. Furthermore, these technologies are gradually automating their process making it. This mode is a quick and easy way to get any device or piece of equipment to work properly. To convey alarm and information effectively, especially during critical times, available means of communication, any aided by technological advancements must be available.

LORAWAN is being used in this study to deliver an alarm signal to every specific location. This will also test the signal's accuracy and dependability for the receivers. In this study, a prototype in the field of communication is being used to examine how quickly and reliably an alarm will spread in a specific geographic area.

As a result of the research, a prototype that will only be used in universities will be created. We'll use an instructional design framework to develop an overarching methodology and data collection approaches. This study focuses on the development of a LORAWAN that will provide alarm signals disasters that may occur at the university. The goal of this initiative is to reduce the number of casualties at the university during the disaster.

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CHAPTER I

THE PROBLEM AND ITS BACKGROUND

Introduction

One of the nations with the highest risk of natural disasters is the Philippines. Its islands frequently experience floods, typhoons, landslides, earthquakes, volcanoes, and droughts due to their location at the intersection of two main tectonic plates at the heart of a typhoon belt. Also, among the top three nations in the world for population exposure and hazard vulnerability is the Philippines.

LORAWAN is a relatively new technology that will be of great use during disasters. The main benefits of this technology are its long-range capability and low cost. LORAWAN is commonly used in smart cities, where low-powered and low-cost internet of things devices distributed across a large area send small packets of data sporadically to a central administrator.

LoRa is an LPWA network technology radio modulation technology for wireless LAN networks. Lora WAN is a LoRa network (protocol). LoRa and Lora WAN are non-cellular LPWAN wireless communication network protocols and players that operate in the unlicensed spectrum.

Communication is critical in all disaster and emergency response and management situations. It enhances how countries deal with people caught up in disasters and conflicts. The use of a technology-assisted communication system will enable effective humanitarian response.

The study intends to enhance alarming capability during emergencies. The current study will assess the performance of the design Lora Wan communications network in an equatorial area such as the Philippines, specifically in RTU Boni Campus Mandaluyong, Metro Manila.

The study intends to design, develop, and implement an emergency alarm system based on LORAWAN communication technology, especially when most communications are down.

Conceptual Framework

The developed and designed LORAWAN system will consider the use of ADAFRUIT LORA RADIO TRANSCEIVER as the medium for evaluating the Accuracy, Precision, Completeness, Consistency, Availability, and Recoverability of the model with respect to Arduino UNO.

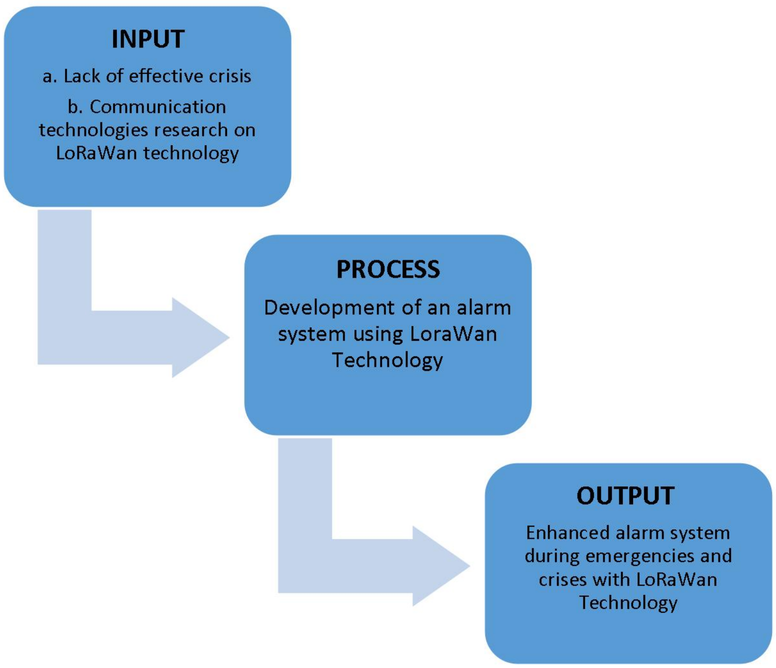

Figure 1. *Research Paradigm of the Study*

The approach taken by the study was guided by the research paradigm. The input, process, and output model illustrated in Figure 1.1 was followed by researchers. The input includes the knowledge sources and subject areas that can be used as the basis of the study. The hardware specifications or essential elements needed for the proposed prototype Alarm system using LORAWAN technology were also included by the researchers. The researchers will also perform data gathering to evaluate the system in terms of accuracy, completeness, availability, consistency, recoverability, and precision. After testing, the researchers will conduct project evaluation and surveying from DRRMO or Disaster Risk Reduction & Management Office of RTU Boni to come up with the desired outcome of the study. The output is expected to be an Alarm system using LORAWAN Technology.

Statement of the Problem

Given the research objectives, the study will attempt to offer solutions to the following research problems:

1. What are the steps undertaken in the design and development of the Alarm System using LORAWAN Technology?
2. What are the evaluations of the DRRMO of RTU Boni based on the prototype's Accuracy, Precision, Completeness, Consistency, Availability, and Recoverability?
3. What factors affect the signal strength in the de signed LORAWAN Alarm System?

Hypothesis

The researchers aim to test the formulated hypothesis that the Alarm system based on LORAWAN Technology is efficient in terms of: Accuracy, Precision, Completeness, Consistency, Availability, and Recoverability.

Objectives of the Study

With the help of Arduino UNO and LORAWAN technology-based alarm systems, this study aims to create a model of an alarm system that can be utilized in any disaster that could happen. Most of the studies discussed various LORAWAN applications, including transmitter, receiver, and so forth. However, there has been little discussion about the use of LORAWAN Technology. The current study aims to accomplish the following objectives:

1. To design and develop a model of an Alarm system based on LORAWAN Technology.
2. To determine the quality of the modeled Alarm system based on LORAWAN Technology.
3. To know the factors that affect the signal strength in utilizing the Alarm system based on LORAWAN Technology.

Scope and Limitations/Delimitations

The study seeks to develop Alarm System Using LORAWAN Technology that can be implemented for any disasters that may happen. With the objective in mind, delimitations are defined to set the scope of the study. It is essential to point out that this research is delimited only in creating a working transmitter and receiver system, one has a button, and the other one has the alarm system and will be tested not in its specific work setting which is an any building or field. The researchers then will use six out of fifteen of the ISO 25012, delimiting out the other nine quality characteristics and only using: Accuracy, Precision, Completeness, Consistency, Availability, and Recoverability.

This study is also subjected to several limitations. As (1) the researchers have limited funding of the development of a prototype to be utilize and tested at a building or field, they are therefore to design a model that will be qualitative and acceptable for the researchers with the little financial provision available; and (2) this kind of research would require enough time to be able to design and develop a model for the study, seeing as we the researchers are students, the time allocated for the study was limited.

Significance of the Study

The study's goal is to develop a device that will be useful in disaster situations. As a result, the team decided to create a device that will assist RTU DRRMO admins, professors, and some students in the event of a disaster. During a disaster scenario, for example, many towers and signals are down. This study can be beneficial to the following:

DRRMO. They may use the designed system to reduce the risk of accidents and to be informed quickly.

Engineering and technology experts. They may utilize the application to explore and maximize the potential of the Alarm System Using LORAWAN Technology.

Students. This study is useful to them, mainly because they can use the procedures undertaken in designing, and further develop their own Alarm System Using LORAWAN Technology.

Definition of Terms

Signal Integrity - this critiques the system's accuracy and refers to the reliability and fidelity of a signal as it travels through a system. It's crucial in ensuring that the transmitted signal remains intact and is accurately interpreted at the receiving end.

ADDIE - is an instructional systems design framework that many instructional designers and training developers use to develop courses. “ADDIE” stands for Analyze, Design, Develop, Implement, and Evaluate.

Arduino - is an open-source hardware and software company, project, and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices.

Availability – This critiques the system's availability in the way of maximizing the utilization of the system, system's ability to be operational and accessible within the required time frame and maintaining a smooth signal.

Completeness - This critiques the system's completeness in the way of achieving full coverage and addressing any potential fluctuations of signals.

LORAWAN - is a license-free radio frequency spectrum wireless audio frequency technology. LoRa is a physical layer protocol that employs spread spectrum modulation to enable long-distance communication at the expense of a limited bandwidth. It sends data using a narrow band waveform with a central frequency, making it resistant to interference.

Consistency - This critiques the system's consistency in the way of achieving consistency in the signal application process and the resulting receiving and transmitting.

ISO25012 – Is a Data Quality Model that defines a general data quality model for data retained in a structured format within a computer system. It can be used to establish data quality requirements, define data quality measures, or plan and perform data quality evaluations.

Programming – is the process of writing code on g-code to facilitate specific actions of LORAWAN Transmitting and Receiving. This consists of a series of commands.

Prototype - is an early sample model of Alarm System Using LORAWAN Technology that would have precise signals that can be delivered.

Recoverability – This critiques the system recoverability in the way of the system's ability to recover from failures, errors, or disruptions and resume normal signals.

CHAPTER II

REVIEW OF RELATED LITERATURE AND STUDIES

This chapter presents the relevant literature and studies that the researchers considered in strengthening the claim and importance of the present study. It focuses on several aspects that will help in the development of this study. The study is generally focusing on the Development of an Alarm System using Lora WAN Technology. This will serve as a guide for the researchers in developing the project.

Emergency Communication Systems

During disasters, emergency communication systems play a critical role in ensuring the safety and well-being of affected communities. These systems can include a variety of technologies, such as:

Radio communication systems: The term "radio communication range" describes the distance across which a radio may communicate data to a receiver clearly and unaltered. Depending on the situation you intend to use a radio communication range for, knowing one is crucial (Talbert, 2018).

Cellular networks: Cellular networks are high-speed, high-capacity voice and data communication networks that support cellular devices through enhanced multimedia and seamless roaming. (Liu, Kotapati, 2014)

Emergency alert systems: According to Federal Communications Commission (2022) The Emergency Alert System (EAS) is a national public warning system that is commonly used by state and local governments to deliver critical emergency information to affected communities, such as weather and AMBER alerts.

Social media: Many business executives today prioritize the concept of social media. Decision makers and consultants alike try to identify ways for businesses to profit from applications such as Wikipedia, YouTube, Facebook, Second Life, and Twitter. (Kaplan, Haenlein. 2010)

Amateur radio: During a major disaster, medical facilities may struggle to maintain effective communications. Natural and man-made disasters pose a threat to connectivity by degrading or disrupting Internet, cellular/mobile, and landline telephone services over large areas. Communications among employees, between facilities, and to resources outside the disaster zone may be disrupted for an extended period of time. (Cid, Mitz, Arnesen,2018)

Each of these systems has its own strengths and weaknesses, and the most effective emergency communication strategy will likely involve a combination of different technologies. Additionally, it's important to have backup systems in place in case primary systems are damaged or otherwise impaired during a disaster.

During crises, emergency communication systems are critical for ensuring the safety of both first responders and the general population. These systems can include a variety of technologies, such as:

Radio communication network: These include traditional analog radios as well as digital systems, such as Project 25 (P25) and Terrestrial Trunked Radio (TETRA). These systems are typically used by first responders, such as police, fire, and emergency medical services.

Cellular networks: Cellular networks, such as those provided by mobile phone companies, can be used for both voice and data communication. These networks can become overloaded during a disaster, so additional capacity may need to be brought in using mobile cell towers or satellite communications.

Satellite communications: This classic guide to satellite communications has been revised, updated, and expanded to cover global wireless applications, digital television, and Internet access via satellite. It has been highly regarded for more than a decade as both a teaching text and a professional tutorial. (Roddy, 2006).

Social media and other internet-based communication tools: Multitasking, handheld devices, and near-constant communication are normal for the "always connected" generation. Millennials, the generation born after 1980, are far less likely to have landline phones, but they have Facebook profiles, a Twitter presence, and send and receive up to 50 texts per day (according to a recent Nielsen Report). Their involvement with technology exceeds that of any other generation, posing a significant challenge to those attempting to reach this hyper-connected group. The competition for these students is fierce for US institutions of higher education, and survival ultimately depends on engaging them using social media and new communications tools. (Barnes, Lescault, 2011)

Emergency alert systems: These systems can be used to send out warning and advisory messages to the general population through a variety of means, such as broadcast television and radio, cable television, and cellular text messages.

It's important to note that during disaster, several of these systems might be impacted, for example radio communication systems may be jammed, cellular networks may be down due to the damage of infrastructure, or the satellite communications might be in high demand, it's important to have multiple communication channels and redundancy in place, to ensure communication continuity during a disaster.

Lora WAN as Communication System

Lora WAN can be used as communication technology for emergency communication systems during disasters. Here are a few potential advantages of using Lora WAN in this context:

Long-range communication and Low-power consumption: Lora WAN Long range low power is a technology family that aims to connect thousands of sensors to the future internet of things. Within this family of potential technology options, two distinct branches have emerged: standards based on spreader wideband communication and standards based on narrowband communication, both of which promise to achieve long-range connectivity at very low power. (Reynders, Pollin, 2016).

Large network capacity: Lora WAN, as stated by Martinez, et al. (2017), Low-power wide area networking technology enables long-distance communication, allowing for new types of services. There are several solutions available, with Lora WAN being the most widely used. It promises ubiquity in outdoor IoT applications while simplifying network structures and management.

Cost-effective: Lora WAN Intelligent agriculture, in general, but especially in highly heterogeneous agricultural fields, necessitates many sensors to achieve effective control and thus increase productivity. Due to the characteristics of the territory and the vineyards themselves, this need becomes more apparent in vineyards on the farms of the demarcated Douro region. As a result, low-cost sensors that are simple to install and maintain are required. In the current work, a node with these characteristics was created, as well as one that is low in power consumption and communicates wirelessly via a Long-Range Wide Area Network (Lora WAN) network (Valente, et. al., 2020)

Multipurpose: Lora WAN, the architecture, as well as the operational principle based on customized Lora WAN networking, of the other two types of nodes, as well as the overall multi-purpose Lora WAN architecture, are novel to our knowledge. (Parrino, et. al., 2021)

However, it's worth noting that Lora WAN is a relatively new technology and not as widely adopted as other communication technologies. Therefore, it may not be the best option in all disaster scenarios. It's important to have multiple communication channels and redundancies in place, to ensure communication continuity during a disaster.

Lora WAN Deployment

Lora WAN deployment varies by country. Some countries have already deployed Lora WAN networks on a large scale, while others are still in the early stages of deployment.

In Europe, Lora WAN works in the unlicensed sub-GHz spectrum, which is established by the standard for most European nations at 868 MHz under CEPT Rec. Regulation of the frequency band 70-03. Only three default channels are recommended by the Lora WAN specification: 868.1 MHz, 868.3 MHz, and 868.5 MHz Despite this, they are among the most often utilized channels in the unlicensed 868 MHz band (863-870 MHz), with a significant likelihood of collision and a high degree of radio noise. Several papers on collisions in the 868 MHz frequency exist. (Fujdiak, et al., 2022)

In North America, the Lora WAN technology's single channel throughput, packet delivery ratio, average packet delay, and end device battery lifespan performance for deployment in an urban setting in North America. The simulation technique is utilized for performance evaluation to account for the operational characteristics of the technology. The simulation findings show that employing four data rates on a single 125 kHz channel increases throughput by 1.8 times over using one data rate. Second, for the hypothetical elderly sensor devices network with 1000 EDs, at least 6 GWs are required to ensure a packet delivery ratio more than 0.8, an average packet latency less than 3 s, and an end device battery lifespan greater than 1300 h. (Wang, Fapojuwo, 2018)

In Asia, according to reports from that year, around 20 million individuals suffered from respiratory difficulties and substantial deterioration in general health because of haze. This calamity has further repercussions on the ecology, economics, flora, and wildlife throughout Southeast Asia. The goal of this study is to create a smart monitoring system that uses a Long-Range Wide Area Network (LoRa WAN) with low power wireless data transfer and

Internet of Things (IoT) technologies. Data can be transferred up to 30 miles using LoRa technology, making it profitable to cover portions of Riau Province that have been severely devastated by this calamity. This article proposes the development of a sensor system capable of detecting land and forest fires. (Kadir, et al., 2018)

It's worth noting that these are just a few examples, and the deployment of Lora WAN varies greatly by country. It's also important to mention that the deployment of Lora WAN networks is an ongoing process, and the situation can change rapidly.

The deployment of Lora WAN in the Philippines is still in the early stages, but it is gaining momentum. Some companies and organizations have started to deploy Lora WAN networks in the country, and the government has also expressed interest in the technology.

In 2019, the Department of Information and Communications Technology (DICT) of the Philippines announced that it was working on the deployment of a nationwide Lora WAN network. The goal of the project is to provide a low-cost, low-power wide-area network that can be used for a variety of applications, such as monitoring and control of devices, data collection and transmission, and location tracking.

Several companies have also started to deploy Lora WAN networks in the Philippines. For example, Globe Telecom, one of the largest telecommunications companies in the Philippines, has started to deploy a Lora WAN network in the country. Another company, Smart Communications, has also announced plans to deploy a Lora WAN network in the Philippines.

Additionally, some organizations and institutions have also started to use Lora WAN in the Philippines. For example, the Philippine Rice Research Institute (PhilRice) has started using Lora WAN for monitoring and controlling irrigation systems in rice paddies.

Overall, it seems that Lora WAN is gaining traction in the Philippines and more companies, organizations, and government agencies are starting to deploy networks and use the technology.

CHAPTER III

METHODOLOGY

The objective of this study is to design a model of a developed Alarm System Using LORAWAN Technology with respect to ARDUINO UNO and test the model using ISO 25012. This chapter explains the methods used to collect data and conduct analysis which is relevant to the study. The chapter describes the research design, the population frame and sample, the description of the respondents, the validity of the research instruments, the procedure for data gathering, and the statistical treatment of the data.

Research Method and Design

In carrying out the study, and collecting the data from the respondents, a descriptive research design was used. It is preferred since it is concerned with answering questions such as who, what when, where, and how. To provide an accurate account of the situation, descriptive research is carefully planned, making sure that there are no biases in collection of data and to reduce errors in the interpretation of the data. The ADDIE model will be used as a guide in the construction of the working model of the study. It is appropriate since the designed model needs to have a clear objective and carefully structured content.

Following the ADDIE model, the existing research problem will be analyzed and thus designing and development of the working model, implementation of the developed model will be done in its specified testing site, prior to this, ISO25012 will be used to evaluate the working model.

Figure 2 *ADDIE Model*

The analysis concentrates on the specifications, objectives, and goals of the project. These consist of the desired characteristics, functionality, and intended uses. The system's overall framework and its parts that deal with the Alarm system using LORAWAN Technology serve as part of the design process. The control software must be coded and tested during the development process to be adjusted and improved. After the Alarm System Using LORAWAN Technology has been fully assembled and integrated in the implementation stage, deploying and testing will commence. DRRMO of RTU Boni and some students will evaluate the prototype to determine its effectiveness using a survey questionnaire based on ISO 25012 standards with a focus on accuracy, completeness, availability, consistency, recoverability, and precision.

Population Frame and Sample

The study population will consist of DRRMO Members and admins of RTU Boni and some students who are available and willing to participate. Purposive sampling was used in this study to select participants. Purposive sampling is the process of selecting sample by taking subject that is not based on the level or area, but it is taken based on the specific purpose Arkunto (2010).

The researcher selects the DRRMO members and admins of RTU Boni and students who can offer the most useful and relevant data. By selecting experts or key informants who have extensive experience or insights related to the research topic, they can provide valuable and unique information. Researchers can optimize their resources and still achieve meaningful results.

The participants are selected based on the purpose and the needs of the study. The researcher then explained the purpose of the study, their rights and that participation was voluntary. The sampling method was used with caution as there may be respondents who may introduce biases in the study. To prevent error, only the respondents who met the inclusion criteria were selected. The sample size of 20 respondents were the total of subjects who were willing to participate in the research and who met the sampling criteria.

Description of Respondents

The respondents for the study consist of DRRMO members and admins and some students who willingly volunteered to participate in the study. The DRRMO are the ones who respond first to any emergency and implementing safety guidelines in any emergency has done so in the past years. They are those who have enough knowledge in the field and will be able to give data that is needed for the study. And some students are eager to participate and learn about the study's aim, as well as how it works.

The DRRMO respondents are from Disaster Risk Reduction & Management Office of Rizal Technological University Mandaluyong. This group consists of professionals as they evaluate the system product, who will evaluate the system using ISO 25012.

Research Instrument

The research instrument/s to be used by the researchers will be survey questionnaires based on ISO 25012. The purpose of this is to ask the sample for their expected outcome of the project and for their feedback regarding the efficiency and safety of the said prototype brought to them. The questionnaire may be done either online, with the use of google forms or not, depending on the situation that will arise, because COVID is still around.

Data Gathering Method and Procedures

The researcher secured a written permit to the DRRMO Office of RTU Boni that would participate in the survey to evaluate the LORAWAN Alarm system. After being given permission, the researcher explained the purpose of the study to the selected respondent and then they made sure each participant corresponds to their predefined criteria. ISO 25012 was used to determine if the effectiveness and quality of work meets the standards of quality model. After the respondent has evaluated the system, the collected data are checked, interpreted, and analyzed. The researchers also included the information from the internet and patented sites and followed by the proper citation for the bibliography.

Statistical Treatment of Data

The T-test was used to compare the difference between the LORAWAN Alarm System and Traditional Alarm System. The T-test measures whether two or more group means are significant between the two. It is often used in hypothesis testing to determine whether a process or treatment affects a population of interest, or whether two groups differ.

The statistical method and/or formulas to be used are described in this part of the research report. The statistical treatment should suit the problems and hypothesis of the study, prior to using ISO 25012, which describes the Accuracy, Precision, Completeness, Consistency, Availability, and Recoverability of the LORAWAN Alarm System. The method of data gathering between the LORAWAN Alarm System and Normal Alarm System is through survey. For the information to be significant to the study, the researchers will use mean and Welch's t-test.

The formula for each of these statistical measures is as follows:

1. Mean Formula = (Sum of Observations) ÷ (Total Numbers of Observations)

$$\overline{X} = \frac{\Sigma X}{N}$$

Where:

- x = the mean value of the set of given data.
- f = frequency of the individual data N = sum of frequencies.

Hence, the average of all the data points is termed as mean.

2. T-test

$$T - value = \frac{mean1 - mean2}{\sqrt{\frac{var1}{n1} + \frac{var2}{n2}}}$$

Where:

- mean1 and mean2 = Average values of each of the sample sets.
- var1 and var2 = Variance of each of the sample sets.
- n1 and n2 = Number of records in each sample set.

Scoring Interpretation

The lowest number (1) was subtracted from the highest number (5), yielding 4, which was then divided by the largest number on the scale (5) to determine the range between the minimum and maximum length of the 5-point Likert scale. When 4 and 5 are divided, the result is 0.80. The difference between an interval's lowest and highest points is represented by the number 0.80. To find the range of the first interval, the computed difference will be added to the smallest number, which is 1. The range of the following intervals will then be determined by adding 0.80 after that. The corresponding interpretations for each interval will be used to present the mean of the questionnaire scores.

Mean	Score Interpretation
1.0 - 1.80	Poor
1.81 - 2.60	Fair
2.61 - 3.40	Satisfactory
3.41 - 4.20	Very Satisfactory
4.21 - 5.00	Excellent

Table 1 Scoring Interpretation

CHAPTER IV

PRESENTATION, ANALYSIS, and INTERPRETATION of DATA

In this chapter, the researcher will present, discuss, interpret, and compare results with the literature. The data is organized with tables and graphs to easily visualize the results.

I. The Steps/Procedures Undertaken in the Design, Development, and Implementation of the Development of an Alarm System Using Lora Wan Technology

The steps/procedures undertaken in the design, development, and implementation of the Development of an Alarm System Using LORAWAN Technology are as follows in response to the first research question:

Analysis Phase – includes the analysis of the project requirements, goals, and objectives. Assess the needs of the people involved and the target audience. Establish the parameters of the LORAWAN Alarm system, including the features, capabilities, and intended applications.

Design phase – includes the software architecture and user interface design for controlling the system using the considered and chosen specification requirements, the overall structure, and components of the system such as the Arduino board, Adafruit LORAWAN, Buttons, and Batteries.

Schematic Diagram

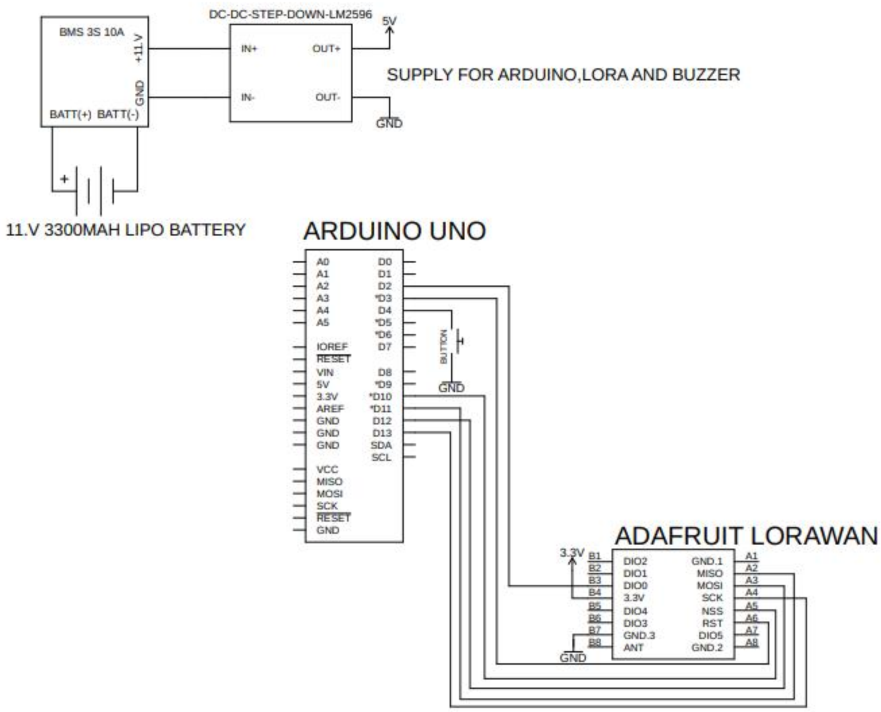

***Figure 3** Schematic Diagram of the Transmitter with Button*

As shown in Figure 3, we have the transmitter of the LORAWAN that holds the button. First is the 11 volts 3300MAH LIPO Battery that are connected to DC-DC-STEP-DOWN_LM2596. The LM2596 is designed to step down the input voltage to a lower output voltage which operates by switching the input voltage on and off rapidly and then filtering and regulating the output to provide a stable DC voltage. Second is the Arduino Uno is connected to Adafruit LORAWAN. The D2 is connected to DIO0 which is to receive a signal. D3 is connected to RST which is to reset the supply or the transmitter. D4 is for the button. D10 is connected to NSS (New Soft Serial) that allows serial communication on other digital pins of an Arduino board, using software to replicate the functionality. D11 is connected to MISO (Master In Slave Out), the connection for the slave device to send data back to the master device. D12 is connected to MOSI (Master OUT SLAVE IN), the connection for the master device to send data to the slave device. D13 is connected to SCK (Serial Clock), the line that carries the clock pulse generated by the master device.

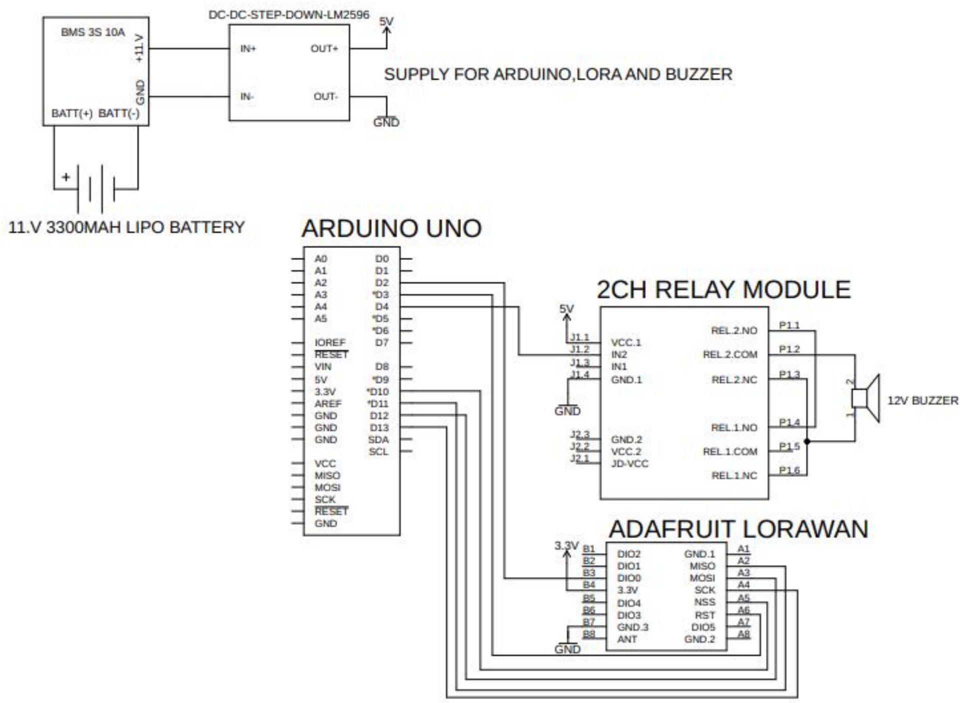

Figure 4 *Schematic Diagram of the Receiver with Alarm*

As shown in Figure 4, We have four parts of the schematic diagram of receiver that each part, if we connected them as one, we would have a good output for the receiver. The difference between the transmitter and the receiver is that we added a 2CH relay module where the buzzer is connected. The 2CH relay module is designed to allow your Arduino to control two high-powered devices.

Technical Design Output

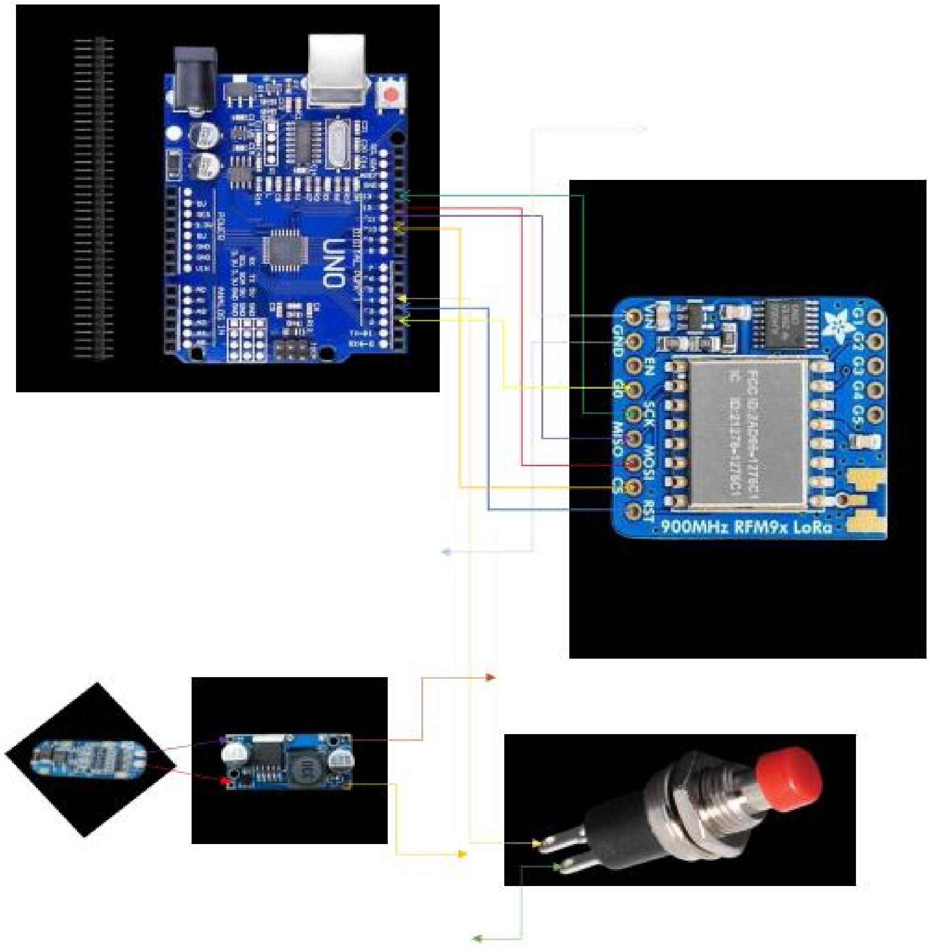

Figure 5 *System Diagram of Transmitter*

Figure 5 shows the materials, we have components such as Arduino Uno, Adafruit LORAWAN, Push button, BMS 3s 10a, 11v 3300 MAH li-po battery, and DC-DC Step down LM2596. Our wirings start with the Battery connected with BMS 3s 10 this is the battery connected with a portable rechargeable kit that has an output of 11v and this is connected to our DC-

DC Step motor that releases an output of 5v that is required to the Arduino uno and the Adafruit. Our DC-DC Step Motor is connected with the Arduino Uno this is main brain of the system that will command the Adafruit in this Arduino Uno also the push button is connected where this will trigger the main alarm, and this will be the crucial point to amplify the signal to the receiver by using the Adafruit. Adafruit is the one that will transmit the command to the receiving end to make an output.

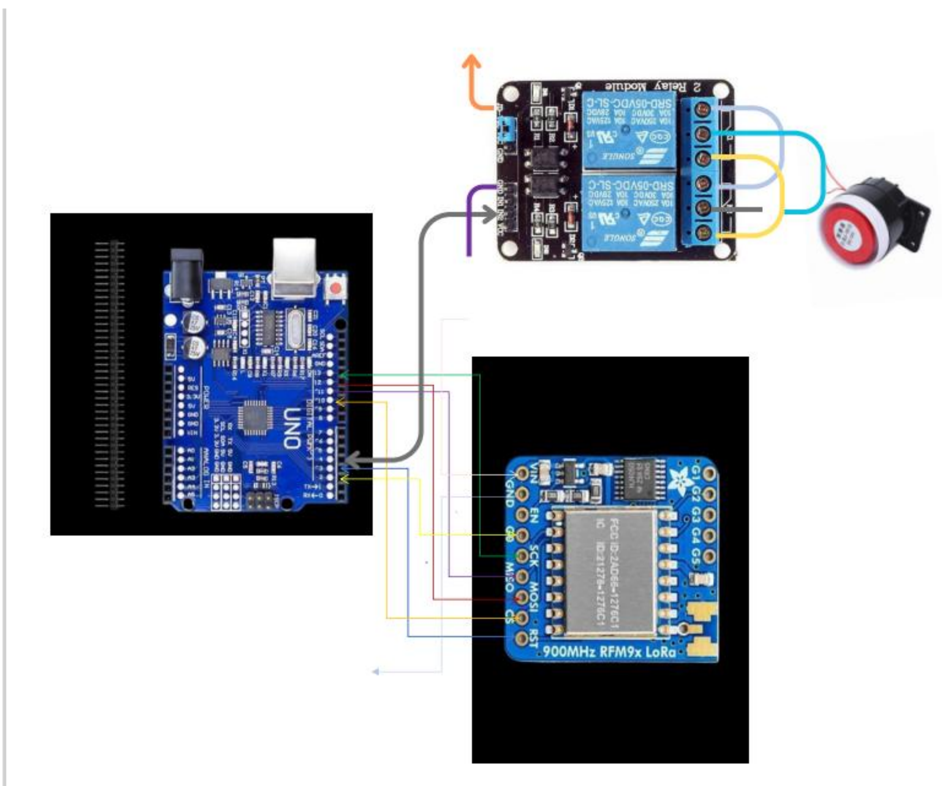

Figure 6 *System Diagram of Receiver*

Figure 6 shows that there is not much change in the components we just add a 2CH Relay Module and an output buzzer.in this diagram it is for the receiver so basically the function of this receiver is to produce an output when they receive an information or command from the transmitter. So, we connected the Adafruit LORAWAN to the Arduino so the connections are when the Adafruit LORAWAN receive an information or command from the transmitter it will send the info to the Arduino to trigger it, so the Arduino is connected to our relay module. So, the Arduino Uno is basically the brain so it will be the one to distribute the command to module so when it receives an info it will now send a command to the relay module. So, the relay module is a component that works like a switch. It turns on and off to be able the current to flow so when it receives an info or command it will turn on to be able to flow the current through the buzzer to make a sound or an output. So, the buzzer we connected it to the module so every time it turns on the buzzer will produce an output.

Software System

As part of the software development of the prototype, of an Alarm System Using LORAWAN Technology is programmed in the Arduino IDE-based software system environment and uploaded to the ATMega328 microcontroller of the Arduino UNO board and Adafruit LORAWAN.

Development phase – includes the application of the designed software architecture and user interface. The procedures are as follows:

Procedure 1 – The Design

The model and dimensions of the Development of Alarm System Using LORAWAN Technology were first modeled and created in sketch pad to show the overall layout plan.

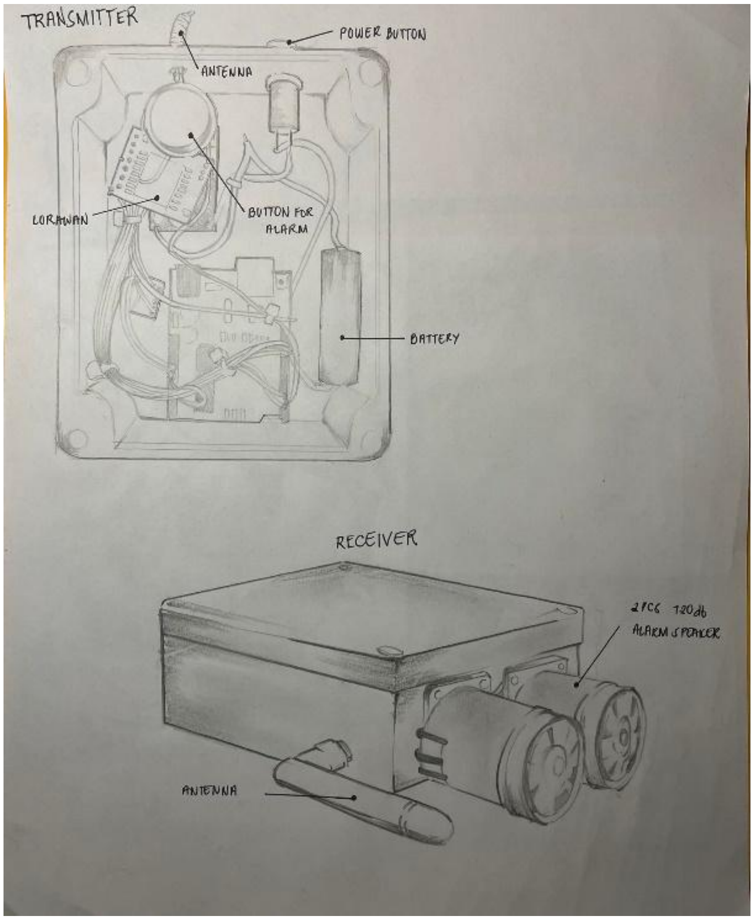

Figure 7 *Prototype Design*

Procedure 2 – The Materials

The materials that were used to create the Alarm System are bought on Amazon website. These materials are the Adafruit Lora Radio Transceiver, 18650 Battery 3.7 V, 2S 5A Lion Battery HX-28-01, BMS 3S 20A 18650 Lithium Battery, Weatherproof Enclosure 151X115X54MM, Relay Module 2 Channel, XL6009 DC-DC Step down Converter and the other materials are bought in the electronic shop.

Figure 8 *Prototype Materials*

Procedure 3 - The Protective Box

We use the Weatherproof Enclosure which has a size of 151 x 115 x 54mm to create a base and to secure the wiring of the prototype.

Figure 9 *Prototype Enclosure*

Procedure 4 – The Wiring Connection

The components or the materials that were used in the Alarm System were positioned in their proper location, also the wire connection of both transmitter and receiver. The transmitter and the receiver are both linked through the use of codes in the Arduino IDE. We used a battery to the transmitter and receiver as the main source of current for them to activate the system.

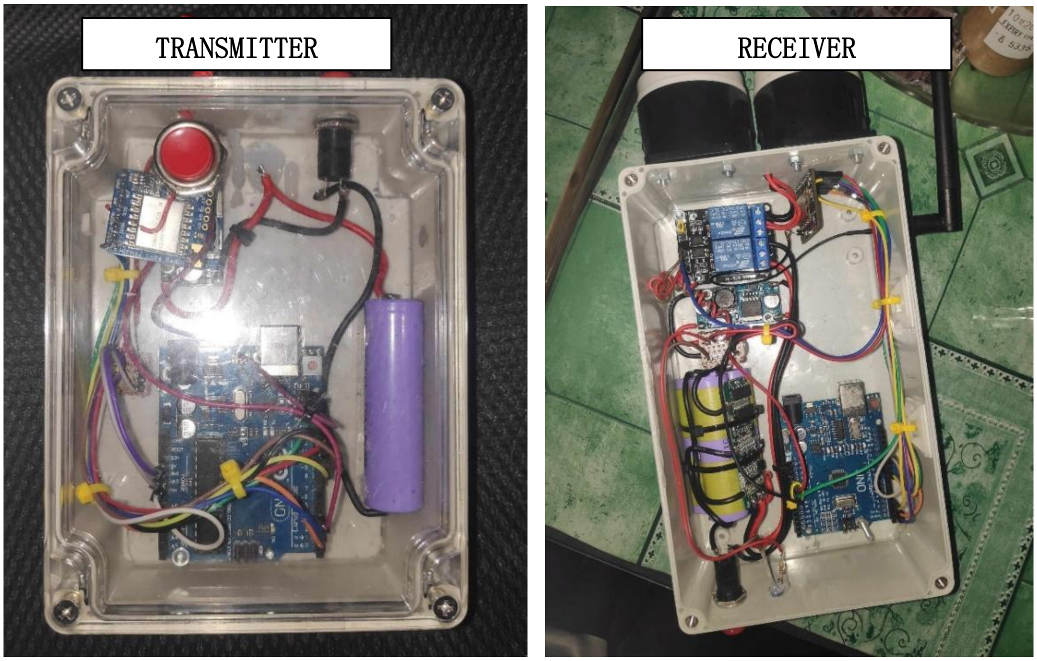

Figure 10 *Prototype Wiring Connection*

Procedure 5 – The Software

We use Arduino IDE to write a code and upload it to the Arduino board. We use a different code for the transmitter and receiver using the Arduino

IDE. To confirm that the codes are correct and if the transmitter was passing the signal to the receiver, the information was tracked in the Arduino IDE.

Implementation phase – The researcher tested the Alarm System Using LORAWAN Technology around Rizal Technology University, Boni Campus, conducting a survey to the students and the staff of DRRMO including the Former Head of the DRMMO, President of DRMMO and the Chief Admin. The researchers demonstrate the prototype to the respondents on how it operates, by doing this survey the respondents will assess the system's accuracy, precision, completeness, consistency, availability, and recoverability using ISO 25012.

Evaluation phase – The Alarm System using LORAWAN Technology has been put through several trials to find the exact range of the signal that will transfer from transmitter through receiver. The researchers test the prototype from the line of sight, building to building and with obstruction, by doing this we can determine the weaknesses of the prototype and the possible changes if the prototype did not reach the expected results from the survey. The researchers use the ISO 25012 to assess the efficiency of the system, focusing on accuracy, completeness, availability, consistency, recoverability, and precision. The effectiveness and quality of the work were assessed using this standard to see if they adhered to a quality model's requirements.

To determine the distance, efficiency and accuracy, the researcher put the working prototype to the test and gathered data. The first trial without obstruction, we used the quadrangle of the RTU Boni corner to corner, we measured the distance and it’s about 70 meters long. And the second trial is with obstruction, and we placed the receiver in the lobby of SNAGAH building RTU Boni, and the transmitter is on the exit of the RTU Boni.

Presentation and Interpretation of Survey Results

II. Survey Result using the ISO 25012

The survey was conducted through survey questionnaires and below are the results that are gathered from their answers.

1. Consistency				
1.1	1.2	1.3	1.4	1.5
4	4	4	4	4
5	5	5	5	4
4	4	4	4	5
4	4	4	4	4
4	4	4	4	4
4	4	5	5	4
5	5	5	5	4
5	5	5	4	5
5	5	5	5	5
4	5	4	4	5
3	3	3	4	3
4	4	5	3	5
5	4	5	4	4
5	3	4	5	5
5	4	5	5	4
5	5	3	5	5
4	4	4	4	4
4	4	4	4	4
4	4	4	5	4

TOTAL MEAN

5	5	5	5	5
4.4	4.25	4.35	4.4	4.35
Excellent	Excellent	Excellent	Excellent	Excellent

AVE: 4.35 – Excellent

Table 2 *Mean and Descriptive Rating of Consistency*

The responses on the evaluation of DRRMO Officers and admins of RTU Boni on the Consistency of the Alarm System using LORAWAN Technology were presented as data in table 2, along with means and score interpretations. 1.1 Regarding how consistent the transmission of alarm signals is using the LORAWAN technology in this system, have a mean average of 4.4 which is interpreted as excellent. 1.2 On the question of "To what extent do you perceive uniformity in the reception of alarm signals across different scenarios using the LORAWAN based system" have a mean average of 4.25 which is interpreted as excellent. 1.3 In regard to the response time of the system in acknowledging and relaying received signals back through LORAWAN, have a mean average of 4.35 which is interpreted as excellent. 1.4 In pertains to the system's ability to maintain consistency in transmitting and receiving signals despite varying environmental conditions such as interference and distance, it has a mean average of 4.4 which is excellent. 1.5 In terms of the stability and how consistent is the integrity of transmitted signals received through the LORAWAN system have a mean average of 4.35 which is interpreted as excellent.

In conclusion, the consistency of the device is highly evaluated by the RTU DRRMO members with a total mean of 4.35, interpreted as excellent.

2. Accuracy				
2.1	2.2	2.3	2.4	2.5
5	4	5	5	5
4	4	5	5	5
5	4	4	4	5
4	5	4	5	4
4	4	4	4	4
5	5	4	5	5
4	4	5	4	5
5	5	5	4	5
5	1	5	5	4
5	1	5	5	4
3	2	3	4	4
4	3	3	5	4
5	3	4	5	5

TOTAL MEAN

5	3	4	5	4
5	3	4	5	5
3	3	3	4	4
4	4	4	4	4
4	3	4	4	4
4	4	4	4	5
4	4	4	5	5
4.35	3.45	4.15	4.55	4.5
Excellent	Very Satisfactory	Very Satisfactory	Excellent	Excellent

AVE: 4.2 - Very Satisfactory

***Table 3** Mean and Descriptive Rating of Accuracy*

The responses on the evaluation of DRRMO Officers and admins of RTU Boni on the Accuracy of the Alarm System using LORAWAN Technology were presented as data in table 3. 2.1 Regarding how accurately does the system notify users or stakeholders about alarm events through the LORAWAN technology? How accurately does the LORAWAN-based alarm system transmit alarms to the intended recipients? have a mean average of 4.35 which is interpreted as excellent. 2.2 On the question of “How frequently do you notice errors or discrepancies in the alarm signals transmitted or received via the

LORAWAN-based system?" have a mean average of 3.45 which is interpreted as very satisfactory. 2.3 In regard to what extent do DRRMO members perceive the received alarm signals maintaining their original integrity without alterations or loss have a mean average of 4.15 which is interpreted as very satisfactory. 2.4 In pertains to how accurate does the system trigger alarms in response to specific events or conditions, it have a mean average of 4.55 which is excellent. 2.5 In terms of how consistently the accuracy of the alarm signals is transmitted and received through the LORAWAN system over varying circumstances have a mean average of 4.5 which is interpreted as excellent.

In conclusion, the accuracy of the device is highly evaluated by the RTU DRRMO members with a total mean of 4.2, interpreted as excellent.

3. Precision				
3.1	3.2	3.3	3.4	3.5
4	4	4	4	4
4	4	5	5	5
5	4	5	4	5
4	5	5	4	5
4	4	4	4	4

4	4	5	5	5
4	4	5	4	5
4	4	4	4	4
4	5	4	5	5
5	5	5	4	5
3	3	3	3	3
5	4	4	4	5
4	4	5	5	4
4	4	5	4	5
5	5	4	5	4
4	4	4	4	4
4	4	4	4	4
4	4	5	4	4
4	4	4	5	4
5	4	5	5	5
4.2	4.15	4.45	4.3	4.45
Very Satisfactory	Very Satisfactory	Excellent	Excellent	Excellent

AVE: 4.31 - Excellent

***Table 4** Mean and Descriptive Rating of Precision*

The responses on the evaluation of DRRMO Officers and admins of RTU Boni on the Precision of the Alarm System using LORAWAN Technology were presented as data in table 4. 3.1 Regarding how accurate the LORAWAN two-way alarm system relay does alarm signals between devices have a mean average of 4.2 which is interpreted as very satisfactory. 3.2 In regard to the extent of the system in maintaining consistent data transmission for alarm signals have a mean average of 4.15 which is interpreted as very satisfactory. 3.3 In regard to how precise is the exchange of alarm related information between interconnected devices via LORAWAN have a mean average of 4.45 which is interpreted as excellent. 3.4 In regard to how accurately the system receives and interprets alarm signals sent from other devices, it has a mean average of 4.3 which is excellent.3.5 In terms of how consistent the quality of alarm signals is received and transmitted via the LORAWAN network have a mean average of 4.45 which is interpreted as excellent.

In conclusion, the precision of the device is highly evaluated by the RTU DRRMO members with a total mean of 4.31, interpreted as excellent.

4. Completeness				
4.1	4.2	4.3	4.4	4.5
5	4	5	5	5
4	4	4	4	5

5	5	4	5	4
4	4	4	4	4
4	4	4	4	4
4	5	4	5	5
4	5	4	4	5
4	4	4	4	5
5	4	5	5	5
5	5	5	5	5
3	4	3	3	5
4	5	5	3	4
5	5	4	4	5
4	5	5	3	4
5	5	5	4	5
4	5	4	4	4
4	4	4	4	4
5	4	3	5	5
3	3	4	3	4
5	5	5	4	5
4.3	4.45	4.25	4.1	4.6
Excellent	Excellent	Excellent	Very Satisfactory	Excellent

AVE: 4.34 - Excellent

***Table 5** Mean and Descriptive Rating of Completeness*

The responses on the evaluation of DRRMO Officers and admins of RTU Boni on the Completeness of the Alarm System using LORAWAN Technology were presented as data in table 5. 4.1 Regarding how reliable you find the system in transmitting complete alarm signals without any loss or corruption during data transfer have a mean average of 4.3 which is interpreted as excellent. 4.2 In regard to the degree of the system on ensuring that the necessary alarm noise is being transmitted for the people to be notified that it is indeed an alarm that is being triggered have a mean average of 4.45 which is interpreted as excellent. 4.3 In regard to how consistent the system is in transmitting and receiving complete alarm signals across various operational conditions have a mean average of 4.25 which is interpreted as excellent. 4.4 In regard to what extent the alarm signals maintain their integrity without loss or alteration, it has a mean average of 4.1 which is very satisfactory. 4.5 In terms of the system's ability to transmit all alarm signals accurately to inform the public about the alarm that is being triggered have a mean average of 4.6 which is interpreted as excellent.

In conclusion, the completeness of the device is highly evaluated by the RTU DRRMO members with a total mean of 4.34, interpreted as excellent.

5. Availability				
5.1	5.2	5.3	5.4	5.5
5	4	5	4	5
4	5	5	4	5
5	5	4	4	5
4	4	5	5	4
4	4	4	4	4
4	4	4	4	4
5	4	4	4	4
5	4	4	5	5
5	5	4	4	4
5	5	5	5	5
3	3	4	3	2
4	4	5	4	3
4	4	4	5	4
4	5	5	4	4
5	4	5	4	3
4	4	4	4	2
4	4	4	4	4
4	5	5	5	4
4	4	5	4	4
5	5	5	5	5
4.35	4.3	4.5	4.25	4
Excellent	Excellent	Excellent	Excellent	Very Satisfactory

TOTAL MEAN

AVE: 4.28 - Excellent

***Table 6** Mean and Descriptive Rating of Availability*

The responses on the evaluation of DRRMO Officers and admins of RTU Boni on the Availability of the Alarm System using LORAWAN Technology were presented as data in table 6. 5.1 Regarding the system's availability in terms of uptime and ensuring the alarm system is consistently accessible, have a mean average of 4.35 which is interpreted as excellent. 5.2 In regard to how effective is the system in promptly recovering from failures or disruptions to maintain its availability has a mean average of 4.3, which is interpreted as excellent.5.3 In regard to how well the system meets the DRRMO members anticipated availability requirements for alarm transmission/reception have a mean average of 4.5 which is interpreted as excellent. 5.4 In pertains to how easily can the two-way alarm system be utilized with only minimal resources; it has a mean average of 4.25 which is excellent. 5.5 In terms of the longevity of the battery life, the LORAWAN two-way alarm system has a mean average of 4 which is interpreted as very satisfactory.

In conclusion, the availability of the device is highly evaluated by the RTU DRRMO members with a total mean of 4.28, interpreted as excellent.

6. Recoverability				
6.1	6.2	6.3	6.4	6.5
4	4	5	5	4
4	4	5	5	5
4	4	5	5	5
5	5	4	5	5
4	4	4	4	4
5	4	5	4	4
4	4	4	4	4
5	4	4	4	4
5	4	4	4	5
5	4	4	4	5
3	3	3	4	4
3	4	4	4	4
4	3	4	5	5
4	5	5	4	5
3	4	5	4	4
4	4	4	4	4
4	4	4	4	4
4	4	4	5	5

	3	4	4	4	4
	4	5	5	5	5
	4.05	4.05	4.3	4.35	4.45
TOTAL MEAN	Very Satisfactory	Very Satisfactory	Excellent	Excellent	Excellent

AVE: 4.24 - Excellent

***Table 7** Mean and Descriptive Rating of Recoverability*

The responses on the evaluation of DRRMO Officers and admins of RTU Boni on the Recoverability of the Alarm System using LORAWAN Technology were presented as data in table 7. 6.1 Regarding the system's ability to recover and restore functionality after a signal transmission failure or interruption has a mean average of 4.05 which is interpreted as very satisfactory. 6.2 In regard to the system, recoverability to restore lost or corrupted data in case of a signal disruption or system failure has a mean average of 4.05 which is interpreted as very satisfactory. 6.3 In regard to the system's speed in recovering from a signal loss or malfunction to resume normal alarm signal transmission have a mean average of 4.3 which is interpreted as excellent. 6.4 In pertains to the extent of the system's redundancy mechanisms ensure continued alarm signal transmission in case of failures or signal loss, it has a mean average of 4.35 which is excellent. 6.5 In terms of how reliable you find the system's recovery procedures in ensuring the continuity of alarm signal transmission under adverse conditions have a mean average of 4.45 which is interpreted as very satisfactory.

In conclusion, the recoverability of the device is highly evaluated by the RTU DRRMO members with a total mean of 4.24, interpreted as excellent.

III. Presentation of the preference of the respondents between Traditional Alarm System and Alarm System using LORAWAN Technology.

Traditional Alarm System and LORAWAN Alarm System.

The researchers prepared another survey for the respondents to know which of the Traditional Alarm System and LORAWAN Alarm System they prefer. The table below shows the preference of the respondents in terms of Accuracy, Precision, and Consistency.

Data Computation in terms of Respondent's Preference

Preference	DRRMO Personnel		Students	
	LORAWAN Alarm System	Traditional Alarm System	LORAWAN Alarm System	Traditional Alarm System
Accuracy	10	0	9	1
Precision	9	1	9	1
Consistency	9	1	8	2

Table 8 *Respondent's Preference*

The preference of DRRMO Personnel and Students for the Alarm System using LORAWAN Technology's accuracy, precision, and consistency is shown in Table 8. As you can see from the table above, the DRRMO Personnel preferred the accuracy of the Alarm System using LORAWAN Technology than the Traditional Alarm System, while the students (9) of them are preferred the Alarm System using LORAWAN Technology and (1) of them are preferred the Traditional Alarm System. For precision, both the DRRMO Personnel and the Students have the same (9) for the Alarm System using LORAWAN Technology. The DRRMO Personnel has a consistency of (9) and the students have a consistency of (8). Therefore, the overall results from the survey of preferences of the alarms, the Alarm System using LORAWAN Technology are preferred by both DRRMO Personnel and the Students.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This study is conducted for the purpose of creating an Alarm System using LORAWAN Technology for the Rizal Technological University, Boni Campus in accordance with ISO 25012 criteria. The results of the survey that the researchers conducted shows that the Alarm System using LORAWAN Technology is functional; regardless of how it functions, the testing of the system shows that there is factors to be considered when using the Alarm system, such as power requirement, obstruction in the surrounding, how much distance will hear the buzzer from building to building and work duration of the system. The study utilizes descriptive research designs, with the ADDIE model being used for prototype creation. The Likert scale survey technique was used for gathering data. The respondents were students at the Rizal Technological University and the Disaster Risk Reduction and Management Office of the University. The mean, median, and mode were used to treat the gathered data to assess the numbers gathered from the prototype.

Summary of Findings

The study's findings are summed up as follows:

The ADDIE model is used in the design, development, and implementation of the Alarm System using LORAWAN Technology in accordance with the two-month-long analysis as well as the interpretation of the data gathered and the material selection for the design process.

By identifying the study's participants – DRRMO RTU BONI Admins and Officers – evaluation on the Alarm System using LORAWAN Technology using the ISO 25012 that is categorized into 6 categories: (1) Accuracy, (2) Precision, (3) Completeness, (4) Consistency, (5) Availability, and (6) Recoverability, this study established that DRRMO RTU BONI Admins and Officers, viewed the developed Alarm System using LORAWAN Technology as very satisfactory.

Based on the Results and Discussion, the DRRMO RTU BONI Admins and Officers evaluation for the Alarm System using LORAWAN Technology in terms of ISO 25012 attributes are listed as follows:

- **Consistency**: consistency of the device is highly evaluated by the RTU DRRMO members with a total mean of 4.35, interpreted as excellent.

- **Accuracy:** accuracy of the device is highly evaluated by the RTU DRRMO members with a total mean of 4.2, interpreted as excellent.

- **Precision**: precision of the device is highly evaluated by the RTU DRRMO members with a total mean of 4.31, interpreted as excellent.

- **Completeness**: completeness of the device is highly evaluated by the RTU DRRMO members with a total mean of 4.34, interpreted as excellent.

- **Availability**: the availability of the device is highly evaluated by the RTU DRRMO members with a total mean of 4.28, interpreted as excellent.

- **Recoverability**: recoverability of the device is highly evaluated by the RTU DRRMO members with a total mean of 4.24, interpreted as excellent.

In general, when it comes to Consistency, Accuracy, Precision, a large majority of the study's participants scored Excellent, which is above average. They preferred the Alarm System using LORAWAN Technology, which may be effective in disasters.

Conclusions

Based on the findings of the study, the following conclusions were drawn:

1. The ADDIE model plays an important role in designing, developing, and implementing and Development of an Alarm System using LORAWAN Technology. Performing a thorough analysis helps in establishing the project's scope and specific goals. Also, it involves designing the

mechanical structure, selecting appropriate Arduino boards, and choosing compatible LORAWAN Module. This also includes assembling the hardware components, writing, or configuring the necessary Arduino code, integrating the control software, and deploying the Alarm System using LORAWAN Technology.

2. According to the data acquired, most respondents were satisfied with the efficiency of the prototype built in accordance with ISO25012. Most of them are impressed with the Alarm System using LORAWAN Technology and believe it will be valuable to them, especially when communication is down and there is limited power during a disaster.

3. The study's conclusions demonstrate that the Alarm System using LORAWAN technology is functional in its current configuration; nevertheless, some elements, such as building disturbances, the location of the system within a building, and battery consumption, affect the system's design and functionality.

Recommendations

On the basis of findings and conclusions of the study, the following are recommended:

1. To advance in terms of Accuracy, Precision, Completeness, Consistency, Availability, and Recoverability, the prototypes' quality characteristics should be improved in accordance with ISO 25012 criteria. One possible way to do this would be to create a better and more complex Alarm System using LORAWAN Technology. Moreover, the outcomes of this investigation could potentially lay the groundwork for an additional use of ARDUINO and LORAWAN Technology, particularly concerning alarm and communication systems.
2. The researchers recommend that future researchers make use of it to validate the system's applicability to various surfaces to establish an Arduino and LORAWAN Technology application. The researcher advises putting the gadget in the best location possible to prevent future signal disruptions and to maximize its usefulness in an emergency. It is advised to think about placing the device in a line of sight, high areas if they are of ideal effectiveness, and where to put the batteries inside the device to improve the suggested system even more.

3. To provide a more accurate representation of the population, the sample size of the research should be given more emphasis and facilitate a larger number of respondents.

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APPENDICES

A. Survey Permit

RIZAL TECHNOLOGICAL UNIVERSITY
College of Engineering and Architecture
Boni Avenue, Mandaluyong City

Dear DRRMO Officers/Admins,

We hope this letter finds you well. We are writing to ask for your permission to conduct a survey for our thesis research project titled "Development of an Alarm System Using LORAWAN Technology." We are students at Rizal Technological University, and this survey is a crucial part of our research.

The survey aims to determine the effectiveness of LORAWAN technology when used in alarm systems. It will help us acquire the information we need to finish our thesis.

Rest assured, all responses will be kept confidential, and no personal information will be shared. The survey will be anonymous, and the data will only be used for academic purposes.

We estimate the survey will take **5-10 minutes** to complete. We plan to distribute it to around **20 people** using hard copies of our surveys.

We understand the importance of following guidelines and rules. We are committed to meeting any requirements set by your organization.

We have included a copy of the survey questionnaire for your review. Your feedback is welcome.

Thank you for considering our request. We look forward to your favorable response.

ENGR. JULIUS FERRER MABANGLO
Capstone Project Adviser

B. Survey for ISO 25012

Development of an Alarm System using LORAWAN Technology

Good day!

We are a group of Rizal Technological University Electronics Communication Engineer students, who are currently conducting research about "Development of an Alarm System using LORAWAN Technology".

A presentation of our project system will be available. Development of an Alarm System using LORAWAN Technology effectiveness and efficiency will be evaluated using the results of this survey.

To be completely transparent, all information provided in this form will only be used for educational purposes and will be kept private.

Name (Optional): ____

Instruction: Kindly rate the following statements based on your assessment of the Alarm System using LORAWAN Technology product quality evaluation according to the following scale:

1 - Not Confident at All

2 - Slightly Confident

3 - Moderately Confident

4 - Quite Confident

5 - Extremely Confident

System Evaluation Criteria

Consistency:

1. How consistent is the transmission of alarm signals using the LoRaWAN technology in this system?

   ○ 1 ○ 2 ○ 3 ○ 4 ○ 5

2. To what extent do you perceive uniformity in the reception of alarm signals across different scenarios using the LoRaWAN-based system?

   ○ 1 ○ 2 ○ 3 ○ 4 ○ 5

3. How consistent is the response time of the system in acknowledging and relaying received signals back through LoRaWAN?

   ○ 1 ○ 2 ○ 3 ○ 4 ○ 5

4. To what degree does the system maintain consistency in transmitting and receiving signals under varying environmental conditions (e.g., interference, distance)?

   ○ 1 ○ 2 ○ 3 ○ 4 ○ 5

5. How stable and consistent is the integrity of transmitted signals received through the LoRaWAN system?

   ○ 1 ○ 2 ○ 3 ○ 4 ○ 5

Accuracy:

1. How accurately does the system notify users or stakeholders about alarm events through the LoRaWAN technology? / How accurately does the LoRaWAN-based alarm system transmit alarms to the intended recipients?

   ○ 1 ○ 2 ○ 3 ○ 4 ○ 5

2. How frequently do you notice errors or discrepancies in the alarm signals transmitted or received via the LoRaWAN-based system?

   ○ 1 ○ 2 ○ 3 ○ 4 ○ 5

3. To what extent do you perceive the received alarm signals maintaining their original integrity without any alterations or loss?

   ○ 1 ○ 2 ○ 3 ○ 4 ○ 5

4. How accurately can the alarm system be triggered in response to specified events or conditions? How accurately does the system trigger alarms in response to specified events or conditions?

   ○ 1 ○ 2 ○ 3 ○ 4 ○ 5

5. How consistent is the accuracy of the alarm signals transmitted and received through the LoRaWAN system over varying circumstances?

   ○ 1 ○ 2 ○ 3 ○ 4 ○ 5

Precision:

1. How accurately does the LoRaWAN two-way alarm system relay alarm signals between devices?

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

2. To what extent does the system maintain consistent data transmission for alarm signals?

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

3. How precise is the speed of the alarm signal that is exchanged between the transmitter to receiver / How precise is the exchange of alarm-related information between interconnected devices via LoRaWAN?

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

4. How accurately does the system receive and interpret alarm signals sent from other devices?

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

5. How consistent is the quality of alarm signals received and transmitted via the LoRaWAN network?

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

Completeness:

1. How reliable do you find the system in transmitting complete alarm signals without any loss or corruption during data transfer?

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

2. To what degree does the alarm system ensure that the necessary alarm noise is being transmitted for the people to be notified that it is indeed an alarm that is being triggered?

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

3. How consistent is the system in transmitting and receiving complete alarm signals across various operational conditions?

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

4. To what extent do you believe the received alarm signals maintain their integrity without loss or alteration?

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

5. How would you rate the system's ability to transmit all alarm signals accurately to inform the public about the alarm that is being triggered?

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

Availability:

1. How would you rate the system's availability in terms of uptime, ensuring the alarm system is consistently accessible?

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

2. How effective is the system in promptly recovering from failures or disruptions to maintain its availability?

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

3. Considering your usage and expectations, how well does the system meet your anticipated availability requirements for alarm transmission/reception?

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

4. How easily can this two-way alarm system be utilized with only minimal resources?

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

5. How would you rate the longevity of the battery life for the LoRaWaN two-way alarm system?

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

Recoverability:

1. How confident are you in the system's ability to recover and restore functionality after a signal transmission failure or interruption?

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

2. In the case of a signal disruption or system failure, how easily do you think the system can restore lost or corrupted data?

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

3. How would you rate the system's speed in recovering from a signal loss or malfunction to resume normal alarm signal transmission?

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

4. To what extent do the system's redundancy mechanisms ensure continued alarm signal transmission in case of failures or signal loss?

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

5. How reliable do you find the system's recovery procedures in ensuring the continuity of alarm signal transmission under adverse conditions?

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

Name(Optional): ___________________________________

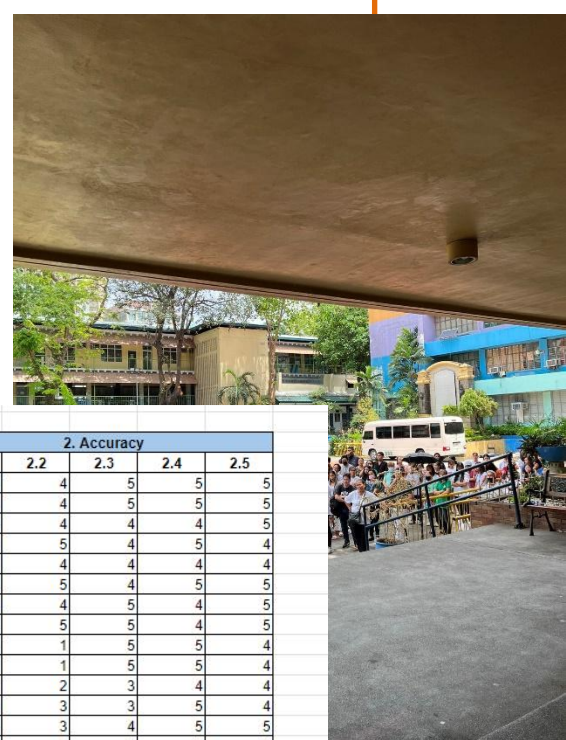
Profession: _______________________________

This survey will be used to determine the preference of the respondents between Traditional Alarm System and LORAWAN Alarm System.

(Kindly check which do you prefer)

In terms of Accuracy, which do you prefer?		
Traditional Alarm System		
LoRa WAN Alarm System		
In terms of Precision, which do you prefer?		
Traditional Alarm System		
LoRa WAN Alarm System		
In terms of Consistency, which do you prefer?		
Traditional Alarm System		
LoRa WAN Alarm System		

C. Survey Presentation/Documentation



D. Data Results

	1. Consistency				
	1.1	1.2	1.3	1.4	1.5
1st Respondent	4	4	4	4	4
2nd Respondent	5	5	5	5	4
3rd Respondent	4	4	4	4	5
4th Respondent	4	4	4	4	4
5th Respondent	4	4	4	4	4
6th Respondent	4	4	5	5	4
7th Respondent	5	5	5	5	4
8th Respondent	5	5	5	4	5
9th Respondent	5	5	5	5	5
10th Respondent	4	5	4	4	5
11th Respondent	3	3	3	4	3
12th Respondent	4	4	5	3	5
13th Respondent	5	4	5	4	4
14th Respondent	5	3	4	5	5
15th Respondent	5	4	5	5	4
16th Respondent	5	5	3	5	5
17th Respondent	4	4	4	4	4
18th Respondent	4	4	4	4	4
19th Respondent	4	4	4	5	4
20th Respondent	5	5	5	5	5
4.4	4.25	4.35	4.4	4.35	4.35
Excellent	Excellent	Excellent	Excellent	Excellent	Excellent

	2. Accuracy				
	2.1	2.2	2.3	2.4	2.5
1st Respondent	5	4	5	5	5
2nd Respondent	4	4	5	5	5
3rd Respondent	5	4	4	4	5
4th Respondent	4	5	4	5	4
5th Respondent	4	4	4	4	4
6th Respondent	5	5	4	5	5
7th Respondent	4	4	5	4	5
8th Respondent	5	5	5	4	5
9th Respondent	5	1	5	5	4
10th Respondent	5	1	5	5	4
11th Respondent	3	2	3	4	4
12th Respondent	4	3	3	5	4
13th Respondent	5	3	4	5	5
14th Respondent	5	3	4	5	4
15th Respondent	5	3	4	5	5
16th Respondent	3	3	3	4	4
17th Respondent	4	4	4	4	4
18th Respondent	4	3	4	4	4
19th Respondent	4	4	4	4	5
20th Respondent	4	4	4	5	5
4.35	3.45	4.15	4.55	4.5	4.2
Excellent	Very Satis	Very Satis	Excellent	Excellent	Very Satisfactory

P

		3. Precision				
		3.1	3.2	3.3	3.4	3.5
	1st Respondent	4	4	4	4	4
	2nd Respondent	4	4	5	5	5
	3rd Respondent	5	4	5	4	5
	4th Respondent	4	5	5	4	5
	5th Respondent	4	4	4	4	4
	6th Respondent	4	4	5	5	5
	7th Respondent	4	4	5	4	5
	8th Respondent	4	4	4	4	4
	9th Respondent	4	5	4	5	5
	10th Respondent	5	5	5	4	5
	11th Respondent	3	3	3	3	3
	12th Respondent	5	4	4	4	5
	13th Respondent	4	4	5	5	4
	14th Respondent	4	4	5	4	5
	15th Respondent	5	5	4	5	4
	16th Respondent	4	4	4	4	4
	17th Respondent	4	4	4	4	4
	18th Respondent	4	4	5	4	4
	19th Respondent	4	4	4	5	4
	20th Respondent	5	4	5	5	5
	4.2	4.15	4.45	4.3	4.45	4.31
ory	Very Satisfactory	Very Satis	Excellent	Excellent	Excellent	Excellent

	4. Completeness				
	4.1	4.2	4.3	4.4	4.5
1st Respondent	5	4	5	5	5
2nd Respondent	4	4	4	4	5
3rd Respondent	5	5	4	5	4
4th Respondent	4	4	4	4	4
5th Respondent	4	4	4	4	4
6th Respondent	4	5	4	5	5
7th Respondent	4	5	4	4	5
8th Respondent	4	4	4	4	5
9th Respondent	5	4	5	5	5
10th Respondent	5	5	5	5	5
11th Respondent	3	4	3	3	5
12th Respondent	4	5	5	3	4
13th Respondent	5	5	4	4	5
14th Respondent	4	5	5	3	4
15th Respondent	5	5	5	4	5
16th Respondent	4	5	4	4	4
17th Respondent	4	4	4	4	4
18th Respondent	5	4	3	5	5
19th Respondent	3	3	4	3	4
20th Respondent	5	5	5	4	5
4.3	4.45	4.25	4.1	4.6	4.34
Excellent	Excellent	Excellent	Very Satis	Excellent	Excellent

	5. Availability				
	5.1	5.2	5.3	5.4	5.5
1st Respondent	5	4	5	4	5
2nd Respondent	4	5	5	4	5
3rd Respondent	5	5	4	4	5
4th Respondent	4	4	5	5	4
5th Respondent	4	4	4	4	4
6th Respondent	4	4	4	4	4
7th Respondent	5	4	4	4	4
8th Respondent	5	4	4	5	5
9th Respondent	5	5	4	4	4
10th Respondent	5	5	5	5	5
11th Respondent	3	3	4	3	2
12th Respondent	4	4	5	4	3
13th Respondent	4	4	4	5	4
14th Respondent	4	5	5	4	4
15th Respondent	5	4	5	4	3
16th Respondent	4	4	4	4	2
17th Respondent	4	4	4	4	4
18th Respondent	4	5	5	5	4
19th Respondent	4	4	5	4	4
20th Respondent	5	5	5	5	5
4.35	4.3	4.5	4.25	4	4.28
Excellent	Excellent	Excellent	Excellent	Very Satis	Excellent

	6. Recoverability				
	6.1	6.2	6.3	6.4	6.5
1st Respondent	4	4	5	5	4
2nd Respondent	4	4	5	5	5
3rd Respondent	4	4	5	5	5
4th Respondent	5	5	4	5	5
5th Respondent	4	4	4	4	4
6th Respondent	5	4	5	4	4
7th Respondent	4	4	4	4	4
8th Respondent	5	4	4	4	4
9th Respondent	5	4	4	4	5
10th Respondent	5	4	4	4	5
11th Respondent	3	3	3	4	4
12th Respondent	3	4	4	4	4
13th Respondent	4	3	4	5	5
14th Respondent	4	5	5	4	5
15th Respondent	3	4	5	4	4
16th Respondent	4	4	4	4	4
17th Respondent	4	4	4	4	4
18th Respondent	4	4	4	5	5
19th Respondent	3	4	4	4	4
20th Respondent	4	5	5	5	5
4.05	4.05	4.3	4.35	4.45	4.24
Very Satisfactory	Very Satis	Excellent	Excellent	Excellent	Excellent

```
// LoRa 9x_TX
// -*- mode: C++ -*-
// Example sketch showing how to create a simple messaging client (transmitter)
// with the RH_RF95 class. RH_RF95 class does not provide for addressing or
// reliability, so you should only use RH_RF95 if you do not need the higher
// level messaging abilities.
// It is designed to work with the other example LoRa9x_RX

#include <SPI.h>
#include <RH_RF95.h>
#define btn 4

int btnflg;

int counter = 0;

//#include <RHGenericDriver.h>
//#include <RHSPIDriver.h>

#define RFM95_CS 10
#define RFM95_RST 3
#define RFM95_INT 2

// Change to 434.0 or other frequency, must match RX's freq!
#define RF95_FREQ 900.0

// Singleton instance of the radio driver
RH_RF95 rf95(RFM95_CS, RFM95_INT);

// Blinky on receipt
//#define LED 13

void setup()
{
  pinMode(btn, INPUT_PULLUP);
  pinMode(RFM95_RST, OUTPUT);
  digitalWrite(RFM95_RST, HIGH);
```

E. Program on Transmitter LORAWAN (Button)

```
  while (!Serial);
  Serial.begin(9600);
  delay(100);

  Serial.println("Arduino LoRa TX Test!");

  // manual reset
  digitalWrite(RFM95_RST, LOW);
  delay(10);
  digitalWrite(RFM95_RST, HIGH);
  delay(10);

  while (!rf95.init()) {
    Serial.println("LoRa radio init failed");
    while (1);
  }
  Serial.println("LoRa radio init OK!");

  // Defaults after init are 434.0MHz, modulation GFSK_Rb250Fd250, +13dbM
  if (!rf95.setFrequency(RF95_FREQ)) {
    Serial.println("setFrequency failed");
    while (1);
  }
  Serial.print("Set Freq to: "); Serial.println(RF95_FREQ);

  // Defaults after init are 434.0MHz, 13dBm, Bw = 125 kHz, Cr = 4/5, Sf = 128chips/symbol, CRC on

  // The default transmitter power is 13dBm, using PA_BOOST.
  // If you are using RFM95/96/97/98 modules which uses the PA_BOOST transmitter pin, then
  // you can set transmitter powers from 5 to 23 dBm:
 // rf95.setTxPower(13, true);
  //rf95.setPayloadCRC(true);
}

int16_t packetnum = 0;  // packet counter, we increment per xmission

void loop()
{
  Serial.println("Sending to rf95_server");
  // Send a message to rf95_server
   if (digitalRead(btn) == 0) {
      delay(100); while(digitalRead(btn) == 0); delay(100);
      char radiopacket[20] = "C";  // Sending 'C'
      Serial.print("Sending "); Serial.println(radiopacket);
      rf95.send((uint8_t *)radiopacket, 2);  // 2 is the length of the message (including null terminator)
      rf95.waitPacketSent();

      // Now wait for a reply
      uint8_t buf[RH_RF95_MAX_MESSAGE_LEN];
      uint8_t len = sizeof(buf);

     }
     else
     {
        btnflg = 0;
        char radiopacket[20] = "O";  // Sending 'O'
        Serial.print("Sending "); Serial.println(radiopacket);
        rf95.send((uint8_t *)radiopacket, 2);  // 2 is the length of the message (including null terminator)
        rf95.waitPacketSent();
     }

//     delay(1000);



}
```

F. Program on Receiver LORAWAN (Alarm Speaker)

```
// Arduino9x_RX
// -*- mode: C++ -*-
// Example sketch showing how to create a simple messaging client (receiver)
// with the RH_RF95 class. RH_RF95 class does not provide for addressing or
// reliability, so you should only use RH_RF95 if you do not need the higher
// level messaging abilities.
// It is designed to work with the other example Arduino9x_TX

#include <SPI.h>
#include <RH_RF95.h>

#define RFM95_CS 10
#define RFM95_RST 3
#define RFM95_INT 2
#define buzzer 4

// Change to 434.0 or other frequency, must match RX's freq!
#define RF95_FREQ 900.0

// Singleton instance of the radio driver
RH_RF95 rf95(RFM95_CS, RFM95_INT);

// Blinky on receipt
#define LED 13
int BuzzerFL = 0;

void setup()
{
  pinMode(buzzer, OUTPUT); digitalWrite(buzzer, 1);

  pinMode(LED, OUTPUT);
  pinMode(RFM95_RST, OUTPUT);
  digitalWrite(RFM95_RST, HIGH);

  while (!Serial);
  Serial.begin(9600);
  delay(100);
```

```
  Serial.println("Arduino LoRa RX Test!");

  // manual reset
  digitalWrite(RFM95_RST, LOW);
  delay(10);
  digitalWrite(RFM95_RST, HIGH);
  delay(10);

  while (!rf95.init()) {
    Serial.println("LoRa radio init failed");
    while (1);
  }
  Serial.println("LoRa radio init OK!");

  // Defaults after init are 434.0MHz, modulation GFSK_Rb250Fd250, +13dbM
  if (!rf95.setFrequency(RF95_FREQ)) {
    Serial.println("setFrequency failed");
    while (1);
  }
  Serial.print("Set Freq to: "); Serial.println(RF95_FREQ);

  // Defaults after init are 434.0MHz, 13dBm, Bw = 125 kHz, Cr = 4/5, Sf = 128chips/symbol, CRC on

  // The default transmitter power is 13dBm, using PA_BOOST.
  // If you are using RFM95/96/97/98 modules which uses the PA_BOOST transmitter pin, then
  // you can set transmitter powers from 5 to 23 dBm:
  rf95.setTxPower(23, false);
}

void loop()
{
  if (rf95.available())
  {
    // Should be a message for us now
    uint8_t buf[RH_RF95_MAX_MESSAGE_LEN];
    uint8_t len = sizeof(buf);
```

```
    if (rf95.recv(buf, &len))
    {
      digitalWrite(LED, HIGH);
      RH_RF95::printBuffer("Received: ", buf, len);
      Serial.print("Got: ");
      Serial.println((char*)buf);

      // Check if the received data is 'C' and perform the action
      if (buf[0] == 'C') {

        if(BuzzerFL == 0){
          digitalWrite(buzzer, LOW);
          Serial.println("Received 'C', turned On buzzer");
//          delay(500);
          BuzzerFL = 1;
        }
        else{
          digitalWrite(buzzer, HIGH);
          Serial.println("Received 'C', turned off buzzer");
//          delay(500);
          BuzzerFL = 0;
        }
      }
//      // Check if the received data is 'O' and perform the action
      else if (buf[0] == 'O') {
//        digitalWrite(buzzer, HIGH);
        Serial.println("Received 'O', turned on buzzer");
      }
      else
      {
        Serial.println("Stop");
      }

    }
    else
    {
      Serial.println("Receive failed");
    }
  }
}
```

Curriculum Vitae

RIZAL TECHNOLOGICAL UNIVERSITY

College of Engineering and Architecture
Boni Avenue, Mandaluyong City

Name : WILLIAM JOHN D. SARMIENTO

Sex : MALE

Birthday : MARCH 21,2000

Age : 24

Religion : ROMAN CATHOLIC

Civil Status : SINGLE

Contact Number : 09281454511

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Parent/s

Mother : ROSITA SARMIENTO

Father : WILFREDO SARMIENTO

Educational Attainment

Tertiary : BS Electronics Communication Engineering

Secondary

Senior High School : Global Innovative College - Tech-Voc ICT-Computer Programming

Junior High School : Ilaya Barangka Integrated School

Primary : Ilaya Barangka Integrated School

RIZAL TECHNOLOGICAL UNIVERSITY

College of Engineering and Architecture
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Name : KIER JOHN V. BADE

Sex : MALE

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Parent/s

Mother : GINALYN BADE

Father : ANGELINO BADE

Educational Attainment

Tertiary : BS - ELECTRONICS ENGINEERING

Secondary

Senior High School : MANDALUYONG HIGH SCHOOL

Junior High School : MANDALUYONG HIGH SCHOOL

Primary : PLAINVIEW ELEMENTARY SCHOOL

RIZAL TECHNOLOGICAL UNIVERSITY

College of Engineering and Architecture
Boni Avenue, Mandaluyong City

Name : CHEREYLEENMAE M. DUBLIN

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Birthday : MAY 10, 2001

Age : 22

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Email Address : dublinchereyleenmae@gmail.com

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Parent/s

Mother : AILEEN M. DUBLIN

Father : REY S. DUBLIN

Educational Attainment

Tertiary : BS Electronics Communication Engineering

Secondary :

Senior High School : Our Lady of Fatima University Antipolo Campus

Junior High School : Bagong Nayon II National High School

Primary : Bagong Nayon II Elementary School

RIZAL TECHNOLOGICAL UNIVERSITY

College of Engineering and Architecture
Boni Avenue, Mandaluyong City

P

Name	: CARL ANGELO DL. BODINO
Sex	: MALE
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Parent/s	
Mother	: LIELANIE BODINO
Father	: ALLAN BODINO

Educational Attainment

Tertiary	: BS Electronics Communication Engineering
Secondary	:
Senior High School	: STI College Ortigas-Cainta
Junior High School	: Francisco P. Felix Memorial National High School
Primary	: Rosario Ocampo Elementary School

RIZAL TECHNOLOGICAL UNIVERSITY

College of Engineering and Architecture
Boni Avenue, Mandaluyong City

Name	:	MICHAEL JOHN C. BARLAAN
Sex	:	MALE
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Age	:	23
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Parent/s

Mother	:	JENNIFER BARLAAN
Father	:	MICHAEL BARLAAN

Educational Attainment

Tertiary	:	BS Electronics Communication Engineering
Secondary	:	
Senior High School	:	Salomague National High School
Junior High School	:	Salomague National High School
Primary	:	Salomague Sur Elementary School

RIZAL TECHNOLOGICAL UNIVERSITY

College of Engineering and Architecture
Boni Avenue, Mandaluyong City

Name :

Sex :

Birthday :

Age :

Religion :

Civil Status :

Contact Number :

Email Address :

Address :

Parent/s

Mother :

Father :

Educational Attainment

Tertiary : BS Electronics Communication Engineering

Secondary :

Senior High School :

Junior High School :

Primary :

RIZAL TECHNOLOGICAL UNIVERSITY

College of Engineering and Architecture
Boni Avenue, Mandaluyong City

Name :

Sex :

Birthday :

Age :

Religion :

Civil Status :

Contact Number :

Email Address :

Address :

Parent/s

Mother :

Father :

Educational Attainment

Tertiary : BS Electronics Communication Engineering

Secondary :

Senior High School :

Junior High School :

Primary :

RIZAL TECHNOLOGICAL UNIVERSITY

College of Engineering and Architecture
Boni Avenue, Mandaluyong City

Name :

Sex :

Birthday :

Age :

Religion :

Civil Status :

Contact Number :

Email Address :

Address :

Parent/s

Mother :

Father :

Educational Attainment

Tertiary : BS Electronics Communication Engineering

Secondary :

Senior High School :

Junior High School :

Primary :

RIZAL TECHNOLOGICAL UNIVERSITY

College of Engineering and Architecture
Boni Avenue, Mandaluyong City

Name :

Sex :

Birthday :

Age :

Religion :

Civil Status :

Contact Number :

Email Address :

Address :

Parent/s

Mother :

Father :

Educational Attainment

Tertiary : BS Electronics Communication Engineering

Secondary :

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