Web-Based Mushroom Monitoring System with Smart Sprinkler

A Capstone Project Presented to the Faculty of the College of Information and Communications Technology

Nueva Ecija University of Science and Technology- Off-Campus Program-General Tinio (Papaya)

In Partial Fulfillment of the Requirements for the Degree Bachelor of Science in Information Technology with specialization in Web Systems Technology

Kevin F. Caluag

2022

CERTIFICATION OF ENGLISH EDITING

This is to certify that this manuscript entitled **Web-Based Mushroom Monitoring System with Smart Sprinkler,** prepared by **Kevin F. Caluag,** was edited by the undersigned. The said manuscript has been found to be acceptable according to the rules of grammar and composition.

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Date:________________

APPROVAL SHEET

This capstone and research project entitled **Web-Based Mushroom Monitoring System with Smart Sprinkler**, prepared and submitted by Kevin F. Caluag in partial fulfilment of the requirements for the degree, Bachelor of Science in Information Technology with Specialization in Web Systems Technology is hereby recommended for approval and acceptance.

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The Researcher

DEDICATION

This endeavor represents the culmination of numerous and arduous efforts. This work is wholeheartedly and proudly dedicated to the individuals who served as a source of inspiration for the proponents, from our parents and guardians and circle of friends who assisted with difficulties and tests during this project.

To the personnel of both NEUST Papaya Off-Campus and Bote Mushroom House;

Above all, to our Almighty God, who has showered us with His blessings in our daily lives, particularly for the strength, courage, patience, wisdom, time, and direction in completing this work.

The Researcher

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ABSTRACT

This capstone and research project, describes the Web-Based Mushroom Monitoring System with Smart Sprinkler (MMS) for Bote Mushroom House. It demonstrates how the system was created throughout the process and the result. This project was created using the Software Development Life Cycle (SDLC) Method, including the Planning, Analysis, Designing, Debugging and Implementation Phases.

The proponents discussed the creation of an MMS for the owner and the farmers of Bote Mushroom House, which would allow the both user's to monitor the status of the mushroom house without entering the mushroom house, by the use of different types of sensor devices attach in a micro-controller called Arduino Uno, it can monitor and control the climate/environment inside the mushroom house.

Having an application of IoT in Agriculture specially in a mushroom house, mushroom farmers can easily monitor the status of the environment of the mushroom house that are suited for the mushrooms and lessen their labor time to make them more reproductive.

The developmental research design was used in this study. This research was carried out in General Tinio, Barangay Rio Chico. The proponent say that the system is flexible and responsive to any kind of gadgets, and the users can easily access the system over the internet.

CHAPTER I

THE PROBLEM AND ITS BACKGROUND

Introduction

According to Briones (2022), "Putting up a sensor, simple sensor that will communicate with your mobile phone and the mobile phone is a simple, inexpensive smartphone. That one has a greater promise of early adoption" smart agriculture covers a wide range of technologies, some of which could be handled by small farmers, by the help of Technology farmers can readily adapt (to). They need to be able to access and even now through data services, mobile phones. There is nothing that will stop farmers from being able to make use of this example of smart agriculture and not have to wait a month, or two months, for the extension officer to come and test their soil and give them advice on the right fertilizer regime given their crop choice.

Other technologies may not require large-scale investment. It could be as simple as an upgraded version of a mobile phone that can run a particular app for sensor-based analysis for (the) purchase of actual equipment for sensor-based analysis of the farm. This could be done at the level of individual farmers. However, they need to be convinced, but That is ultimately the key to smart agricultural transformation (Briones, 2022).

Mushrooms are delicacy food items praised for their characteristic texture when biting and enjoyable flavor. They have received overwhelming attention from food and pharmaceutical researchers due to their bioactive constituents (Sheu et al., 2007, Mariga et al., 2014).

Mushroom farming, just like any other farm, can be benefited from using IoT. The usual manual activities can be eased by leveraging various available sensing devices. Sensor technologies can accurately monitor the major environmental factors that affect stalk height, stalk diameter, and capsize in mushrooms hence enabling the regulation of air temperature, humidity, and compact materials (Bellettini, et al., 2015). Several problems may arise when the ecological factors are not monitored and regulated (Bellettini et al., 2015). Even elevated inoculum amounts or the number of holes in mushroom cultivation packages result in the developing of non-desired organisms such as bacteria andnematodes. The effects of those problems are indeed undesirable because it affects production.

This study employed a developmental research method to develop a web-based automated mushroom monitoring system to make it possible. The proponent used the Web-Based platform and Internet of Things using an Arduino microcontroller to create this system.

Literature Review

IOT in Smart Agriculture

The Internet of Things makes “dumbed” things “smart “by connecting them to the internet. IoT enables devices embedded with sensors to connect to and interact with each other via the internet (Agriculture Victoria, 2020).

IoT is about the power of data. Our world is digitally connected, and data is a critical asset. Data from devices can guide farmers’ decisions, helping them farm smarter and safer and adapt more quickly to changing conditions. Monitoring farm conditions and infrastructure remotely can free up time, labor, and capital to invest, allowing farmers to focus on other things.

Understanding Internet of Things

The internet of things, or IoT, is a system of interrelated computing devices, mechanical and digital machines, objects, animals, or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human- to-human or human-to-computer interaction (Gillis, 2022). A thing in the internet of things can be a person with a heart monitor implant, a farm animal with a biochip transponder, an automobile that has built-in sensors to alert the driver when tire pressure is low, or any other natural or artificial object that can be assigned an Internet Protocol (IP) address and can transfer data over a network.

Increasingly, organizations in various industries are using IoT to operate more efficiently, better understand customers to deliver enhanced customer service, improve decision-making and increase the value of the business (Gillis, 2022).

How IOT in Agriculture works

In agriculture, IoT-based smart farming systems can help monitor, for instance, light, temperature, humidity, and soil moisture of crop fields using connected sensors. IoT is also instrumental in automating irrigation systems (Gillis, 2022).

Some organizations have dedicated IoT in their organization, like in a smart city. IoT sensors and deployments, such as smart streetlights and smart meters, can help alleviate traffic, conserve energy, monitor and address environmental concerns, and improve sanitation. In healthcare, IoT offers many benefits, including the ability to monitor patients more closely using an analysis of the generated data. Hospitals often use IoT systems to complete tasks such as inventory management for both pharmaceuticals and medical instruments.

The Internet of Things (IoT) has the potential to transform the ways we live in the world; we have more-efficient industries, more connected cars, and smarter cities, all these as components of an integrated IoT system. The ever-growing global population will touch around 9.6 billion by 2050. So, to feed this immense population, the agriculture industry needs to embrace IoT. The demand for more food has to meet challenges such as rising climate change, extreme weather conditions, and environmental impact resulting from intensive farming practices (DataFlair, 2022).

Opportunities of using IOT in agriculture

- remote monitoring of farm conditions and infrastructure, saving time and labor on routine farm checks.
- improving producers' decision making through data analytics
- faster and quicker insights from real-time data across the value chain, helping farmers respond to what the market wants
- efficiency in how we produce food to ensure less wastage, expediency to market, and enhanced traceability to demonstrate safe and sustainable food to our customers
- building the capabilities to respond to new and emerging technologies and investing in research and

development to contribute to ongoing innovation and improved productivity.

Smart Agriculture Modes, Trends and Benefits

Farming has seen technological transformations in the last decades, becoming more industrialized and technology-driven. By using various smart agriculture gadgets, farmers have gained better control over raising livestock and growing crops, making it more predictable and improving its efficiency (Chalimov, 2020).

Smart agriculture is a new agricultural production mode that contributes to agricultural information perception, quantitative decision-making, intelligent control, precise investment, and personalized service through the deep integration of modern information technologies, e.g., the internet, Internet of Things (IoT), big data, cloud computing, and Artificial Intelligence (AI) with agriculture. In short, the new model is a smart agricultural solution that combines agriculture with modern information technology (Sinica, 2020).

Smart Farming Modes:

1. **Real-Time monitoring:** A Smart Farming monitoring in which farmers can easily see or review the monitoring status of the farms.
2. **Wireless connectivity:** A easy way of accessing the status of farms in any location.
3. **Crop management:** One more type of IoT product in agriculture and another element of precision farming are crop management devices. Like weather stations, they should be placed in the field to collect data specific from cropping farming, from temperature and precipitation to leaf water potential and overall crop health. Thus, you can monitor your crop growth and any anomalies to prevent any diseases or infestations.

Recorded history can be traced through agriculture. When we started planting and sowing crops, we started to evolve as a society. So, if we can use agriculture to measure our success and value as a society, what is the current smart farming trend (Mazzei, 2021).

Smart Farming Trends:

1. **The growing adoption of the Internet of Things (IoT):** A growing application of IoT solutions in agriculture by using smart agriculture sensors to monitor the state of crops, farmers can define exactly how many pesticides and fertilizers they have to use to reach optimal efficiency.
2. **Greenhouse automation:** farmers use manual intervention to control the greenhouse environment. The use of IoT sensors enables them to get accurate real-time information on greenhouse conditions such as lighting, temperature, soil condition, and humidity.

There are many reasons to implement a smart agriculture solution into commercial and local farming. In a world where the internet of things is accelerating the adoption of data gathering and automation, an important industry such as agriculture can surely benefit. Here are some benefits of implementing a smart agriculture solution (C2M, 2016).

Smart Agriculture Benefits:

1. Data, tons of data, collected by smart agriculture sensors: Weather conditions, soil quality, crop growth progress, or cattle's health. This data can be used to track the state of your business in general as well as staff performance, equipment efficiency, etc.
2. Better control over the internal processes and, as a result, lower production risks: The ability to foresee the output of your production allows you to plan for better product distribution. If you know exactly how many crops you will harvest, you can make sure your product won't lie around unsold.
3. Increased business efficiency through process automation: You can automate multiple processes across your production cycle using smart devices, e.g., irrigation, fertilizing, or pest control.
4. Precision Farming: Precision farming is a process or a practice that makes the farming procedure more accurate and controlled for raising livestock and growing crops.

5. Water Conservation: Weather predictions and soil moisture sensors allow for water use only when and where needed.
6. Lower Operation Costs: Automating processes in planting, treatment and harvesting can reduce resource consumption, human error, and overall cost.
7. Equipment Monitoring: Farming equipment can be monitored and maintained according to production rates, labor effectiveness, and failure prediction.

IoT in Mushroom Farming

Marzuki & Ying (2017) presents a system for monitoring and controlling mushroom farms. It has a circuit with a monitoring function that includes a monitoring function that enables the user to monitor temperature, humidity, and light intensity in a mushroom farm wirelessly and control the sensors' mushroom farm condition feedback. Their monitoring system obtains data from the sensors and sends it to ThingSpeak online cloud for monitoring and storage. Also, users can access the data anytime via the Internet and download the data into a CSV file for further analysis.

They also designed an Android app interface for easy data monitoring.

The IoT-based Monitoring and Environment Control System for indoor cultivation of oyster mushrooms used Arduino UNO as a controller to integrate data from the sensor and send it to the IoT platform through a wireless module (Mohammed et al., 2017). The ThingSpeak IoT platform visualizes the data submitted, and it is available to Android or IOS apps linked to the same platform. The data received on mobile apps is displayed in sensor value, a graph in the time domain for visualizing the data trend, and used as a control parameter to the connected device.

Mushroom Farming

Mushroom can be grown at indoor or outdoor environment. In modern farming, mushroom is preferably to be cultivated in controlled indoor environment as to maximize the production. It is noted that mushroom growth is highly influenced by air temperature and humidity. Ideal condition for mushroom cultivation is temperature between 22 to 26 ∘C with relative humidity (RH) of 80-90% (Tariqul et al., 2016a)

Related Systems

ThingSpeak

ThingSpeak is an Internet of Things (IoT) platform that lets you collect and store sensor data in the cloud and develop IoT applications. The ThingSpeak IoT platform provides apps that let you analyze and visualize your data in MATLAB, and then act on the data, Your device or application can communicate with ThingSpeak using a RESTful API, and you can either keep your data private or make it public. In addition, use ThingSpeak to analyze and act on your data (Techi Expert, 2020).

Agricultural Drones

Farming is one of the major verticals to consolidate both ground-based and airborne rambles for trim wellbeing evaluation, water system, edit observing, edit splashing, planting, soil and field examination, and other spheres. Since rambles collect multispectral, warm, and visual symbolism whereas flying, the information they accumulate give agriculturists with bits of knowledge into a entirety cluster of measurements: plant wellbeing files, plant tallying and surrender forecast, plant stature estimation, canopy cover mapping, field water lake mapping, scouting reports, stockpile measuring, chlorophyll estimation, nitrogen substance in wheat, seepage mapping, weed weight mapping, and so on (Sciforce, 2020).

Smart Irrigation System

Smart irrigation are far-reaching. By monitoring soil moisture levels, a smart water irrigation system allows farmers to automate their irrigation processes and reduce water use. In addition to more efficient consumption of resources.

Smart water system frameworks make broad utilization of IoT sensors. These sensors, put within the field, send real-time information to a central portal that then naturally switches on a water pump at whatever point dampness or temperature values are exterior the foreordained range. Wireless low-power systems like LoRa enable IoT sensors and make it conceivable for data to stream in genuine time to and from the central door. The complete keen water system framework can be overseen by an conclusion client through a custom cloud-based stage or portable application (Intellias, 2021).

Each of the studies includes the use of sensors and has both desktop and mobile access. A few of the studies offer offline availability (Pravinth & Rozario,2020), but what sets the system apart from other studies is that it is accessible offline and has a Smart sprinkler to maintain the proper moisture of the farms.

Synthesis

After reviewing the related literatures regarding the researcher capstone topic, the researcher learned that most of the manual operations with the aid of online web-based system and Internet of Things (IOT). This transition happens slowly and sometimes drastically due to certain necessity and circumstances like costing amount. With this fact, the researcher believe that the necessity for digitalization is unavoidable. As the researchers know that their research locale will soon have a mass productions of mushrooms, they need a fully automated web-based monitoring system to handle the manual labor process and avoiding mushroom to die so it is important to develop system that will be beneficial for the research local.

Moreover, the proponents also reviewed different system that have connection to their topic to determine which features should add to the proposed system and what they could done based on the study’s scope and limitations, aside from it many of the related system use only an free cite name Thingspeak to gathered information from a microcontroller called Arduino, because of this the researcher want to developed the MMS in Laravel framework and work for it from the scratch. The researcher decided to pick up different features from different system and combined them for the system that researcher developed so the proposed system could comply on the necessity of the recipient.

The proponents gained confidence and courage regarding the future job route they wished to pursue as a result of knowledge gained from review on both related literature, Information that the researcher had collected from different websites and article has similarities with the researcher's study. The researcher's study will include sensors to monitor the climate or the environment of the farms.and systems. This study shows the value of technology in streamlining and simplifying daily tasks. Technology raises the standard of living and empowers individuals to contribute more to society.

Conceptual Framework

The Project "Web-Based Mushroom Monitoring System with Smart Sprinkler" was developed using Agile development methodology. Agile is a term used to describe approaches to software development emphasizing incremental delivery, team collaboration, continual planning, and continual learning instead of trying to deliver it all at once near the end.

Agile focuses on keeping the process lean and creating minimum viable products (MVPs) that go through several iterations before anything is final. Feedback is gathered and implemented continually, and in all, it is a much more dynamic process where everyone is working together towards one goal (Visual Paradigm, 2020). This methodology is embedded into the research paradigm of the IPO or input-process-output model, which was also used by most researchers, according to Canonizado (2020), as shown in Figure 1.

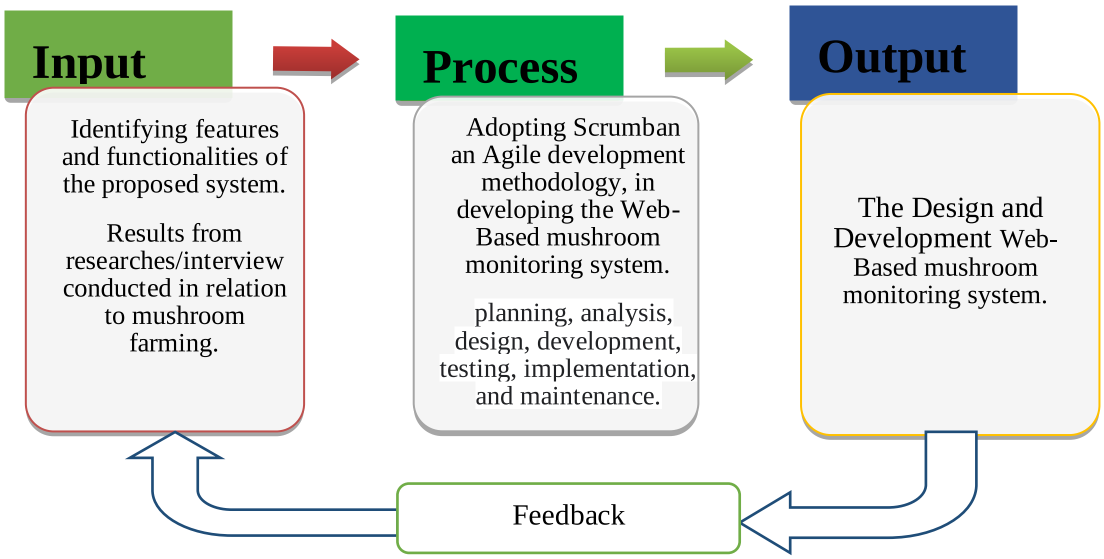

Figure 1. Research Paradigm

In Figure 1, for the input phase, the researcher conducted a series of research and interviews regarding the methods, procedure, and flow of the Mushroom Monitoring System. In addition, the researcher used Benchmarking of systems used by different farms was also done.

The researcher used Scrumban, an Agile development technique, during the process phase. It is a cross between Scrum and Kanban (Martinuzzi, 2019). Scrumban is becoming increasingly popular in in-service businesses, according to Pajuha (2015), where we have both development and maintenance projects.

Finally, the researcher presented the developed Web-based Mushroom Monitoring System during the output phase. In addition, things like user guides and training were considered throughout the implementation and maintenance of the system. In addition, reviews and feedback were gathered in order to improve the system further. According to the table 1, the project took thirty-six (36) weeks to complete.

Table 1. ***Project Schedule***

	ACTIVITY/ TASK	NO OF WEEKS
1	ANALYSIS STAGE - Defining System Requirements	12
2	DESIGN & DEVELOPMENT STAGE - Prototyping - Scrumban procedures	30
	Total Weeks	42

Statement of the Problem

The Philippines is a tropical country suitable for growing mushrooms (ResearchGate,2013). Cultivating shiitake and button mushrooms requires cold environments, which is one of the obstacles to planting mushrooms. Cultivating mushrooms in open hot weather can cause the mushroom to dry and die (Mariga, 2014), so this research aims to develop a "Web-Based Mushroom Monitoring System with Smart Sprinkler" that can handle and maintain the proper environment for the mushrooms.

This research involved developing and evaluating a "Web-Based Mushroom Monitoring System with Smart Sprinkler." A real-time monitoring system focused on mushroom farming.

The study was looking for answers to the following research questions:

1. How may the "Web-Based Mushroom Monitoring System with Smart Sprinkler" be developed using the Agile Model phases in terms of:
    - 1.1 Defining requirements;
    - 1.2 System design;
    - 1.3 Development;
    - 1.4 Quality assurance;
    - 1.5 User acceptance testing.

Scope and Limitations of the Study

The study Web-Based Mushroom Monitoring System with Smart Sprinkler focused on understanding the needs of every farmer. This study also covered and analyzed different studies, technologies, devices, and third-party software, from simple to complex, which can be included and related to the study's development.

The study's main features were a real-time monitoring system and a smart sprinkler for the mushroom house. It can be done by using the Microcontroller called ARDUINO UNO and different types of sensors useful for monitoring the status of the mushroom house. This study designed and developed a reliable smart farming system (IoT) to reduce farmers' time costs and resources. The system can detect temperature, detect the level of present CO2 in the surrounding, detect the present level of light, detect humidity of the surroundings, and smart sprinklers, detect the mushroom progress and remotely monitor it, but the system cannot prevent the insects in the agriculture facility.

Significance of the Study

This study will be beneficial to the following:

- **Markets.** With this research markets will have a continues supply of the products cause by continuous increasing production rates.
- **Farmers.** This research is for the benefit of farmers, having an application of IoT in Agriculture specially in a mushroom house, farmers can easily monitor the status of the environment of the mushroom house that are suited for the mushrooms and lessen their labor time to make them more reproductive.
- **Owner.** With this research, owner can gain or have an increase of their production rates in terms of mushrooms.
- **Future Researchers.** The results of the study will be useful for future researchers with the interest in developing system with integration of Internet of Things (IOT) as their basis and references that will lead for better idea for their innovation.
- **The Researcher.** The researcher is expected to learn more about the Internet of Things and Web development. The project was an opportunity to learn

new knowledge they had never experienced during class. The project helps the researchers come up with new plans for them to solve a certain problem in developing the project. The researchers also understood the processes in mushroom farming and how different factors can affect the growth of mushrooms.

Definition of Terms

The terms used in this study were operationally defined below for better comprehension and for clarity as to the context they had been used in this study.

ARDUINO UNO: refers to an open-source electronics platform or board and the software used to program it. Arduino is designed to make electronics more accessible to artists, designers, hobbyists and anyone interested in creating interactive objects or environments. An Arduino board can be purchased pre-assembled or, because the hardware design is open source, built by hand. Either way, users can adapt the boards to their needs, as well as update and distribute their own versions (Techopedia).

Internet of Things (IOT): describes the network of physical objects "things" that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet (Oracle, 2022).

MMS: is a Web-Based Mushroom Monitoring System with Smart Sprinkler. It is the general term that serves as the blueprint or class of the system.

Mushroom: is the reproductive structure produced by some fungi. It is somewhat like the fruit of a plant, except that the "seeds" it produces are in fact millions of microscopic spores that form in the gills or pores underneath the mushroom's cap (Ministry of Forests).

Microcontroller: microcontroller is an integrated circuit (IC) device used for controlling other portions of an electronic system, usually via a microprocessor unit (MPU), memory, and some peripherals (Keim, 2019).

Platform: is a collection of technologies that serve as a foundation for the development of further applications, processes, or technologies (Techopedia, 2020).

Smart farming: is an emerging concept that refers to managing farms using technologies like IoT, robotics, drones and AI to increase the quantity and quality of products while optimizing the human labor required by production.

CHAPTER II

METHODOLOGY

This chapter represents the methods and procedures employed throughout the study, including research design, data gathering procedures, data gathering instruments, research local, and research respondents.

Research Design

This study took a developmental approach to its research. Richey & Seels (1994) defined opposed to simple instructional development, has been described as "the systematic study of designing, developing and evaluating instructional programs, processes, and products that must meet the criteria of internal consistency and effectiveness." The most typical types of developmental research are investigations into and explanations of the product development process and evaluations of the completed product. According to the conceptual framework, Scrumban was used in particular.

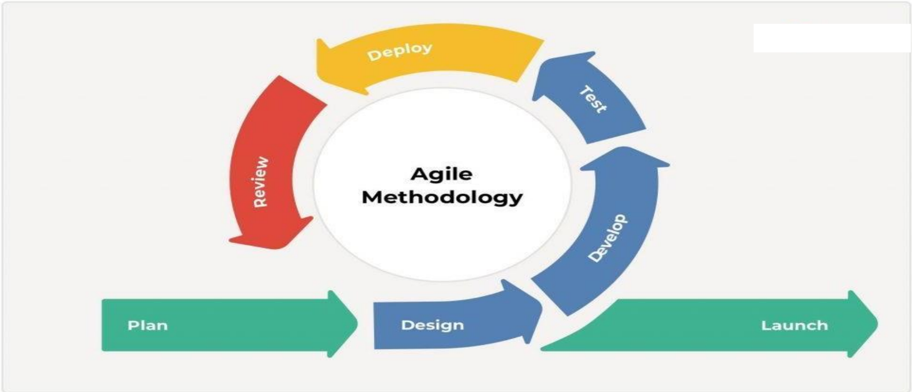

Figure 2. Scrumban Model

After identifying requirements based on the data collected, specified tasks were divided into modules. These modules were prioritized and grouped based on different factors such as dependencies, the time required for development, and developmental difficulties. These can be visualized in a Scrumban board as product backlogs.

The actual process of system development was done using the different steps in the Scrumban process, such as (Pajuha, 2015):

1. Visualizing the work identified as product backlogs through a Scrumban board which is divided into different labeled columns known as sprints like

"Backlog," "To Do," "In Progress," and "Done." Here, the product backlogs will be called sprint backlogs.

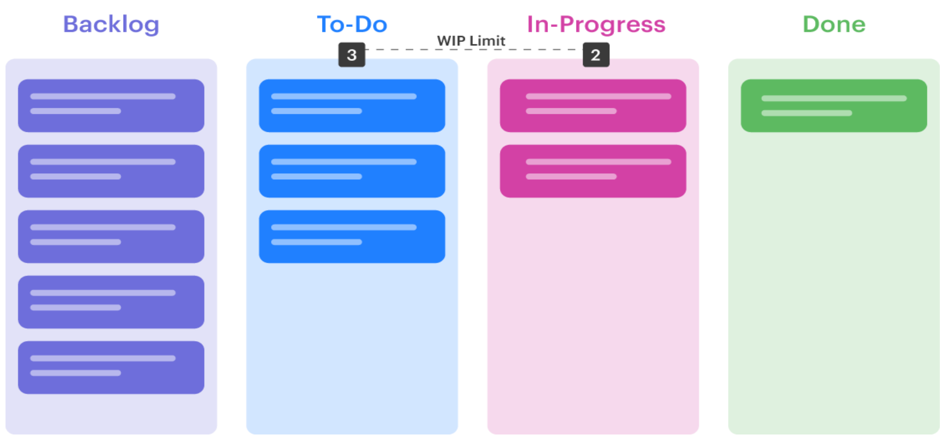

Figure 3. Scrumban Board

1. Apply for Work in Process Limit (WIP) in every sprint based on the capability of the developer to avoid work overload and rush in every sprint.
2. In every work done in a sprint, the developer must transfer the sprint backlog to the next right column and pulls other sprint backlogs from the left column or sprint.
3. The transfer of sprint backlog from one column to another is not essentially left to right. The sprint can be turned back in the previous sprint

based on the review of the developer or tester, such as done in the "test" sprint. If a sprint passed on Quality Assurance, it would be transferred to "done sprint," but if it fails, it will be turned back to a development sprint.

4. The process will continue as a loop until all the modules have completed the system.

To ensure the quality and readiness of each sprint, the developer will cooperate with other people, such as potential users.

Research Local

The study was conducted at the Bote Mushroom Farm, one of the mushroom farms in the Municipality of General Tino province of Nueva Ecija, Philippines, located at Purok 4 Barangay Rio Chico.

Bote Mushroom Farm aims to increase the production rates of mushrooms in the Municipality of General Tinio. As we all know, farming is the livelihood of a majority of the residents.

Even though located at the foot of the Sierra Madre

Mountain Ridges, the topography is generally plain ideal for agricultural products such as palay, vegetables, and fungi. The developed system will be deployed soon on that mushroom Farm. Bote Mushroom house is composed of 1 room with a width of fifteen (15) meters and fifteen (15) meters in height, and they started it this year (2012).

Figure 4. Image of the facility of Research Locale

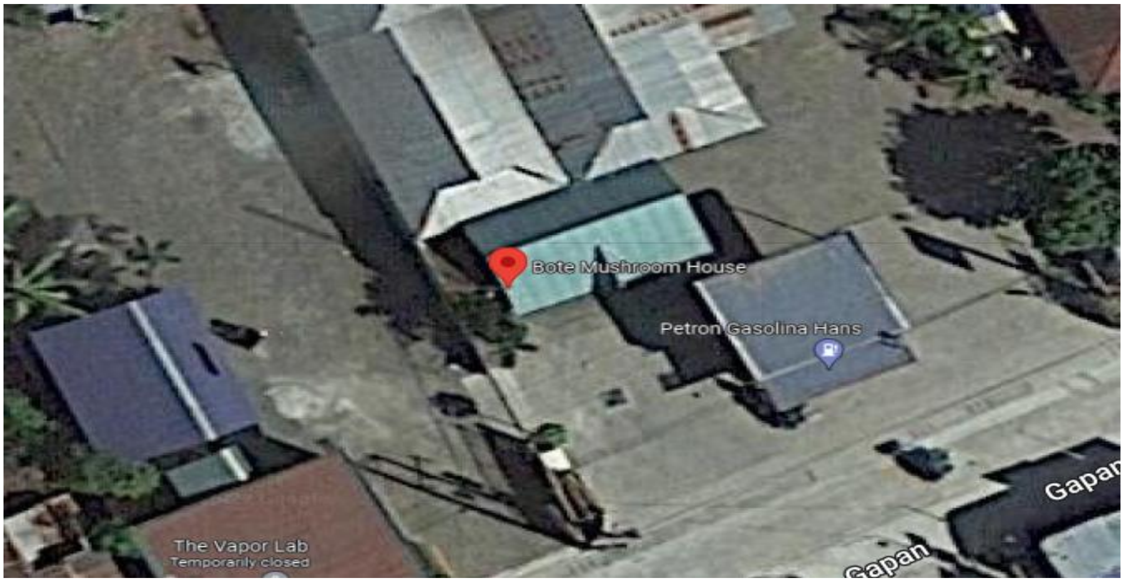

Figure 5. Google Earth View of the Research Locale

There were two groups of respondents in the study – the Fungiculture and the System End-users. The Fungi culturist expert group are the experts for cultivation of mushrooms, total Fungi culturist experts' respondents are 2, and lastly is the System Users group are divided into 2 sets first is the Owners, and second in the staffs or the employees, total System Users respondents are 29.

Collectively, there were 31 respondents that composed two (2) Fungi culturist experts, fifteen (15) primary users and fourteen (14) secondary users as shown in Table 2 below.

Table 2. ***Distribution of Respondents***

Classification	Population
Fungi culturist Expert	2
Primary Users (Owners)	15
Secondary Users (staffs/employees)	14
Total	**31**

Samples and Sampling Strategy

A purposive sample was used in this study. According to Alchemer (2021), Purposive sampling, also known as judgmental, selective, or subjective sampling, is a form of non-probability sampling in which researchers rely on their judgment when choosing members of the population to participate in their surveys. The method for performing purposive sampling is fairly straightforward. All researchers must reject the individuals who do not fit a particular profile when creating the sample.

Research Instrument

To evaluate the developed system, the researcher employed Printed Questionnaires to collect data from the respondents. A questionnaire is a research instrument consisting of questions to gather information from respondents. Questionnaires can be thought of as a kind of written interview. They can be carried out face to face, by telephone and by computer. Questionnaires provide a relatively cheap, quick and efficient way of obtaining large amounts of information from a large sample of people Saul (2018).

Requirments Analysis

The Proponent need to know the details of the current state of the system:

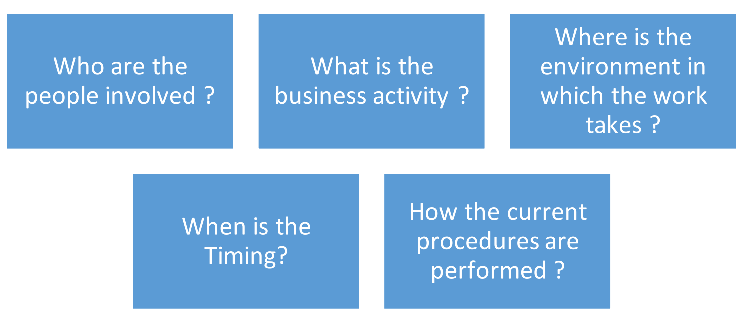

Figure 6. Analysis

Requirements Documentation

The photos below show the discussions and arrangements between the proponent, capstone adviser and the owner of the mushroom house said in the research locale. This includes the system proposal, system updates, and gatherings of data. Furthermore, as the project progresses.

Picture 1 : Meeting with the recipient

Data Gathering Procedure

This research was divided into two stages: development and implementation and assessment. Data for the development stage was gathered through web searches, printed questionnaires, and interviews with specialists from Central Luzon State University to find the appropriate features for the mushroom farming, The researcher also conducted online research for more features that can be applied to the system and how to develop Real-Time

Monitoring System using a micro-controller called Arduino that can be used in different types of computers such as desktops smartphones. The development phase only takes place only after the necessary information is gathered. Development began with the sequence planning, followed by the analysis of the system to understand its nature and determine its essential features. The next phase was the construction of the system and program design, coding of the software program, testing and implementing the output iteratively, and the maintenance requirements and considerations of the system. User acceptance testing happened after Web-Based Mushroom Monitoring System with Smart Sprinkler 24 passing from the quality assurances conducted into system packages. Also, the packages that passed acceptance testing were released and implemented.

Ethical Concerns

According to Insights (2020), Research ethics are moral principles that guide researchers to conduct and report research without deception or intention to harm the participants of the study or members of the society as a whole, whether knowingly or unknowingly. Practicing ethical guidelines while conducting and reporting research is essential to establish the validity of your research.

In addition, it educates and monitors scientists' research to ensure a high ethical standard. The following is a general summary of some ethical principles:

- Honesty.
- Integrity.
- Respect of intellectual property.
- Responsible publication.
- Human subject protection

Table 3. ***Ethical Table***

Ethical issue	Definition
Voluntary participation	Participants have the option to join or leave the research at any time.
Informed consent	Before agreeing or declining to participate, participants are informed about the study's objective, benefits, risks, and funding.
Anonymity	The participants' identities are unknown to you. No personally identifiable information is gathered.

Confidentiality	You know who the participants are, but you keep it a secret from the rest of the group. You anonymize personally identifying information so that no one else can relate it to other information.
Potential for harm	The risk of physical, social, psychological, and other forms of harm is maintained to a bare minimum.
Results communication	You ensure that your work is devoid of plagiarism and research misconduct, and that your results are appropriately represented.

In paying attention to those ethical issues in the evaluation phase, the researcher carefully followed guidelines for unbiased data collection. For example, though the questionnaire asked the participants' names, they were not obliged to answer it to keep them anonymous if they did not want. Also, the researcher asked the experts to analyze the collected data to make the study free from plagiarism and accurately represent the result of the study.

CHAPTER III

RESULTS AND DISCUSSIONS

This chapter presents the development phases of the system and the analysis and interpretation of the data gathered during evaluation phase to answer the research questions to satisfy the objectives of the study.

Development of MMS: A Real-Time mushroom monitoring system with smart sprinkler.

Project Initialization and Requirement Analysis Stage

A mushroom requires precise monitoring to grow better, know the proper way to produce it, and know what factors affect its growth. A real-time monitoring system became the project spark-up to initialize the development of MMS: A Mushroom Monitoring System with Smart Sprinkler to have better production and lessen the work time for farmers to monitor it manually.

After the overviewing, the researcher started researching and interviewing for the different features the Mushroom Monitoring System should have and the platforms and devices that can be used. The researcher's cue is to favor developing the system from scratch. It measures a system's ability to extend and the effort necessary to implement the expansions. It is defined as "the property of being designed to allow the addition of new capabilities or functionality." It is important in the development since the project did not only focus on a Real-Time Monitoring System but also added some devices like Arduino to have a climate control system.

Designing Stage

Soon after the researcher analyzed the data, he developed and prepared system designs of the work packages and system functionalities that will be the features of the system. The system designs that were developed are the USE Case Diagram, Context Diagram, Data flow Diagram. Since the system was developed through, it is important to construct these system designs in the first iteration, for they serve as a guide of the development team to develop each deliverable stated in the work breakdown structure. The first design developed was the Use Case Diagram. Figure 7 shows the system users or roles interaction with the MMS in a form of use case diagram.

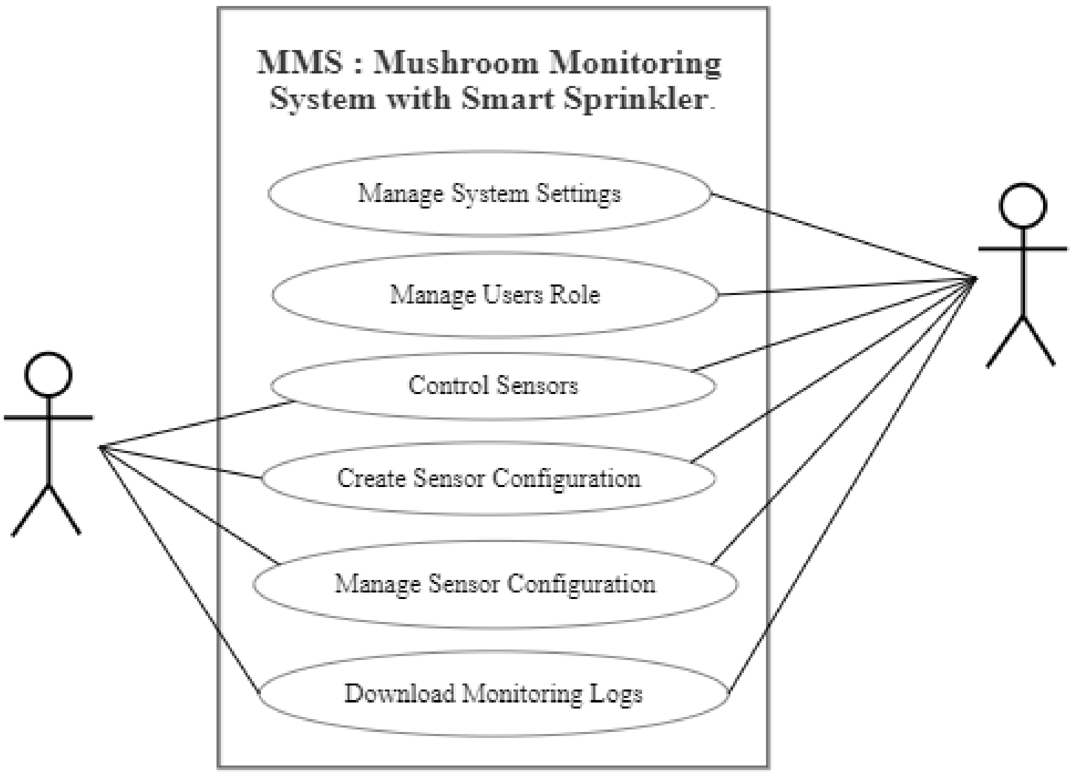

Figure 7. Use Case Diagram

Figure 7 shows two (2) actors: The administrator and the Employees. The Administrator role can manage the whole System Setting and configuration and define and manage Sensors Configurations. This role can also make or generated monitoring report about the system and download it.

Context diagram was created for easy visualization of the data process, external entities and the developed system as single as high-level process was created as shown in Figure 8.

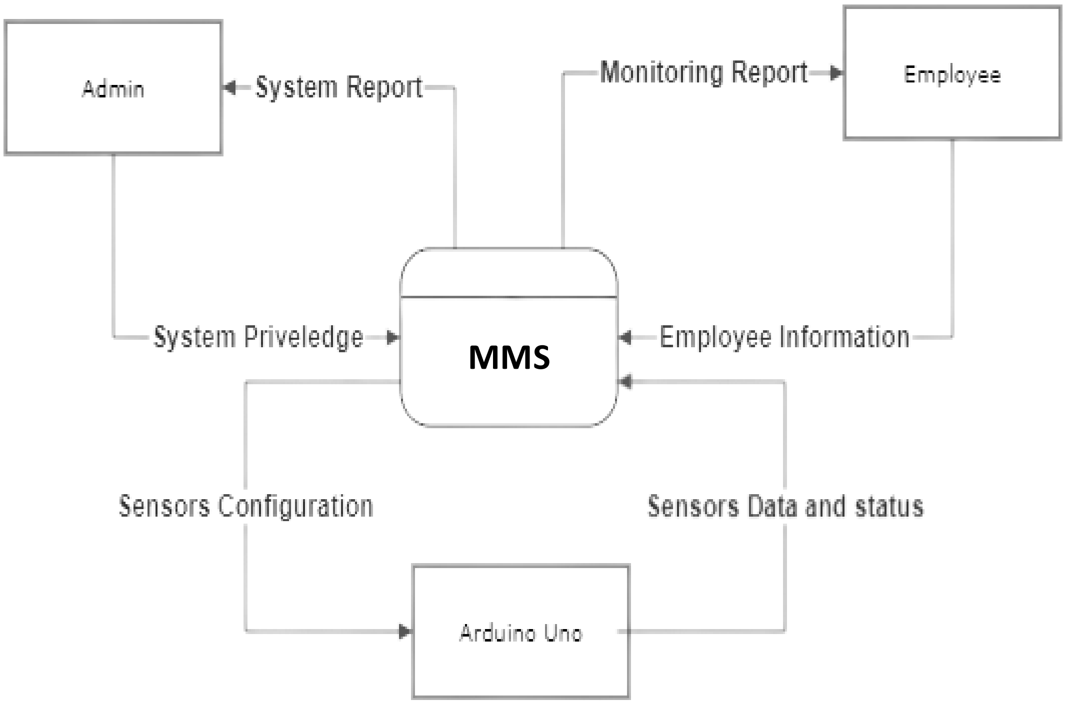

Figure 8. Context Diagram

The researcher thoroughly examined the created DFD level 0, where five (5) main functions and processes were drawn. These are "system settings and user management," "Real-Time monitoring logs," "Sensor Configurations," and "Report

Generation." The DFD level 0 has been produced to depict it clearly. Figure 9 shows the System's Data Flow Diagram Level 0.

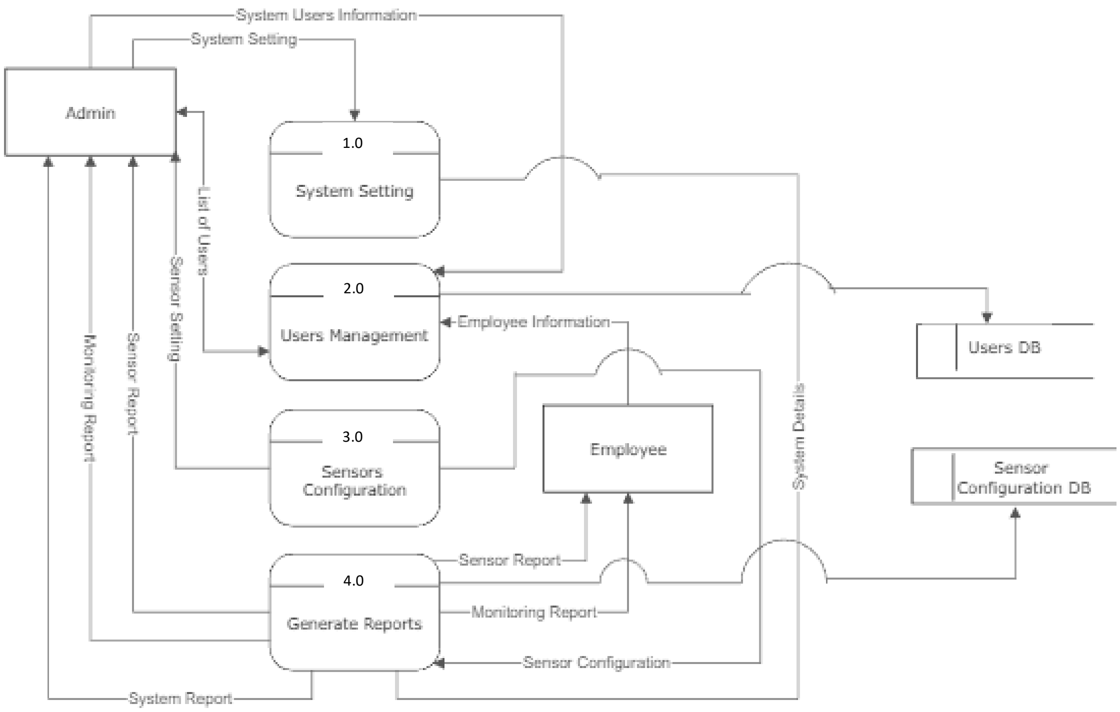

Figure 9. DFD Level 0

To exhibits the subroutines or process within each detected functionality, Data Flow Diagram Level 1 was also generated as shown in the following figures.

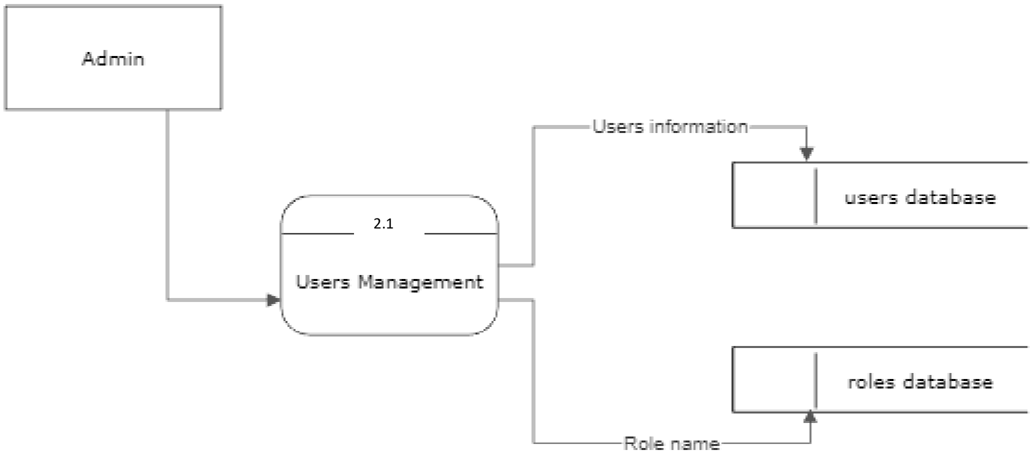

Figure 10. Users Management DFD level 1

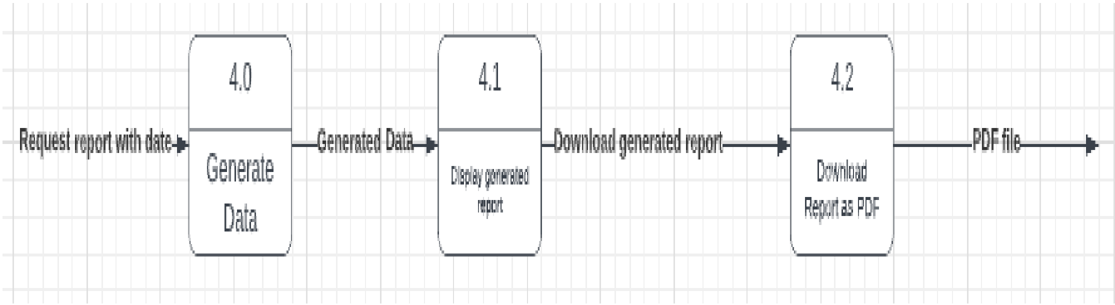

Figure 11. Generate Report sub-processes DFD level 1

MMS Databased, composed of 10 tables, were used in the system to work correctly. The following figures are some of the currently accompanying tables in the system.

Table	Action	Rows	Type	Collation	Size	Overhead
carbondioxides	Browse Structure Search Insert Empty Drop	10	InnoDB	utf8mb4_unicode_ci	16.0 KiB	-
humidities	Browse Structure Search Insert Empty Drop	10	InnoDB	utf8mb4_unicode_ci	16.0 KiB	-
lights	Browse Structure Search Insert Empty Drop	10	InnoDB	utf8mb4_unicode_ci	16.0 KiB	-
notifications	Browse Structure Search Insert Empty Drop	8	InnoDB	utf8mb4_unicode_ci	16.0 KiB	-
roles	Browse Structure Search Insert Empty Drop	2	InnoDB	utf8mb4_unicode_ci	16.0 KiB	-
sensorsconfigurations	Browse Structure Search Insert Empty Drop	3	InnoDB	utf8mb4_unicode_ci	16.0 KiB	-
soilmoistures	Browse Structure Search Insert Empty Drop	0	InnoDB	utf8mb4_unicode_ci	16.0 KiB	-
temperatures	Browse Structure Search Insert Empty Drop	10	InnoDB	utf8mb4_unicode_ci	16.0 KiB	-
users	Browse Structure Search Insert Empty Drop	2	InnoDB	utf8mb4_unicode_ci	48.0 KiB	-
waterlevels	Browse Structure Search Insert Empty Drop	0	InnoDB	utf8mb4_unicode_ci	16.0 KiB	-
10 table(s)	Sum	55	InnoDB	utf8mb4_general_ci	192 KiB	0 B

Figure 12. MMS Tables.

Development and Testing

In this stage, the researcher used the scrumban board to track the progress and the specific task to be done known as "Sprint Backlogs". It is just a customized board using excel application. It is composing of six (6) columns that labeled as "sprint backlogs", "in progress", "peer review", "in test", "for revision" and "deploy in the hosting". Those labels represent the status of each backlog. The column "sprint backlogs" states that a backlog is not yet done but already planned.

	A	B	C	D	E	F
1–2	Sprint Backlogs	In Progress	Peer Review	In Test	For Revision	Deploy in the hosting
3						Laravel Framework Scaffolding
4						Middlewares
5						Laravel Routes
6					Monitoring Chart Data	
7				Temperature sensor		
8				Humidity sensor		
9				Lights sensor		
10				Co2 sensor		
11			Arduino Uno sensor simulation			
12		Notifications Logs				
13		Controlling arduino using web				
14	Generating reports and					
15	export as PDF file					
16	Uploads Sensor					
17	Configuration Setting in					
18	CSV file					
19						

Figure 13. Scrum Board

During the development as well in modification phase, the researcher used Visual Studio and Arduino IDE as text editor for the readability of the programming syntax. Here are the environments of the two text editors that has been mentioned.

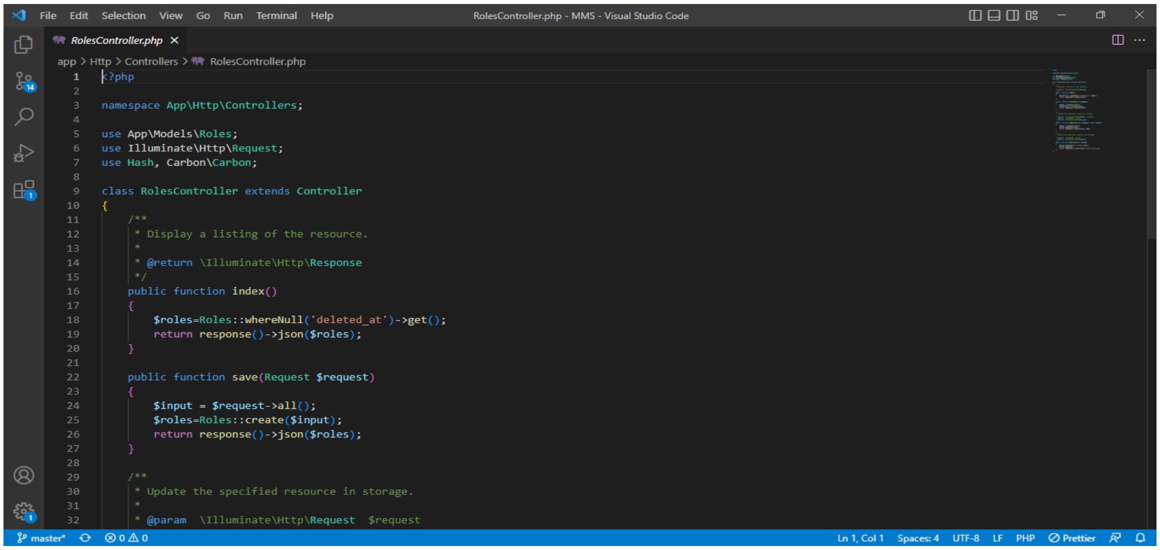

Figure 14. Visual Studio Code Text Editor Environment

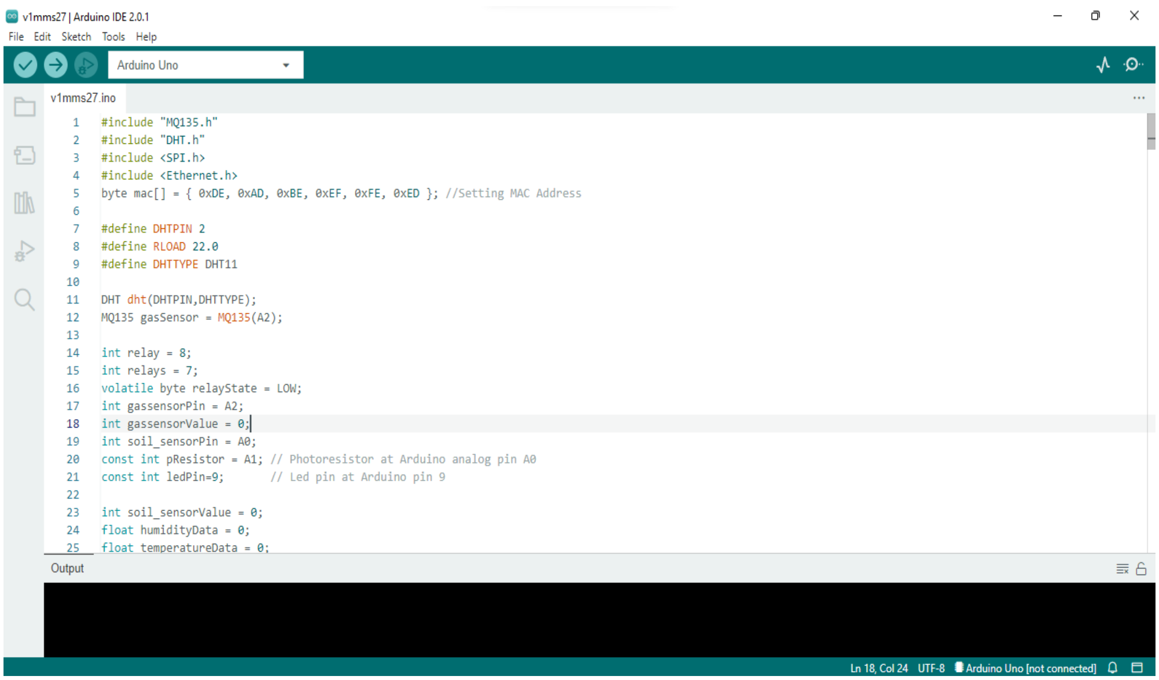

Figure 15. Arduino IDE Environment

Coding Interface

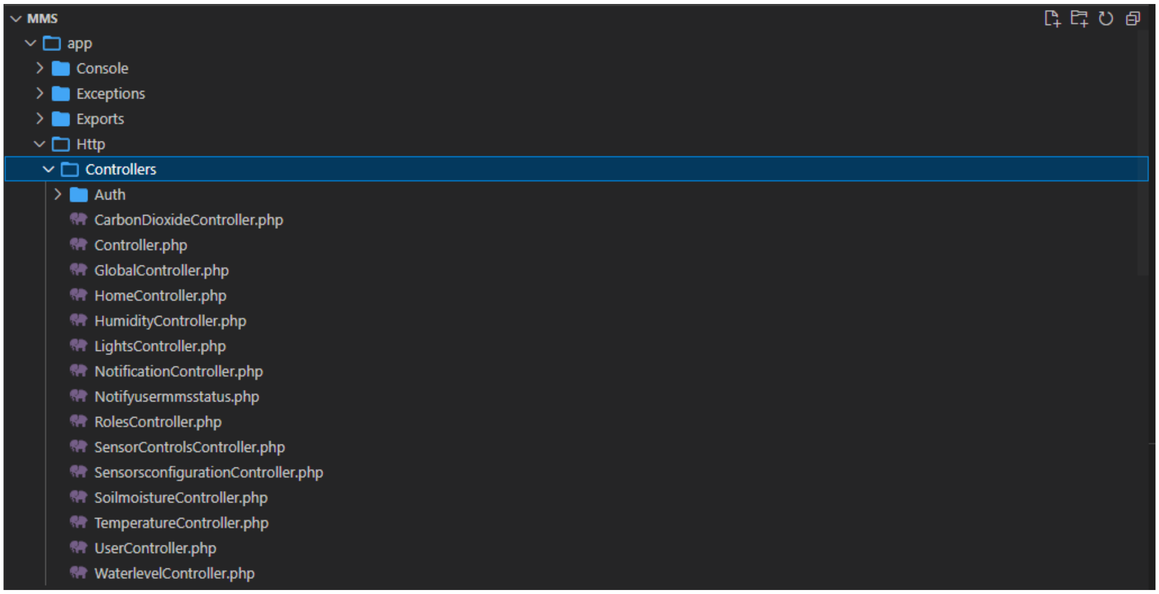

Figure 16. Controllers

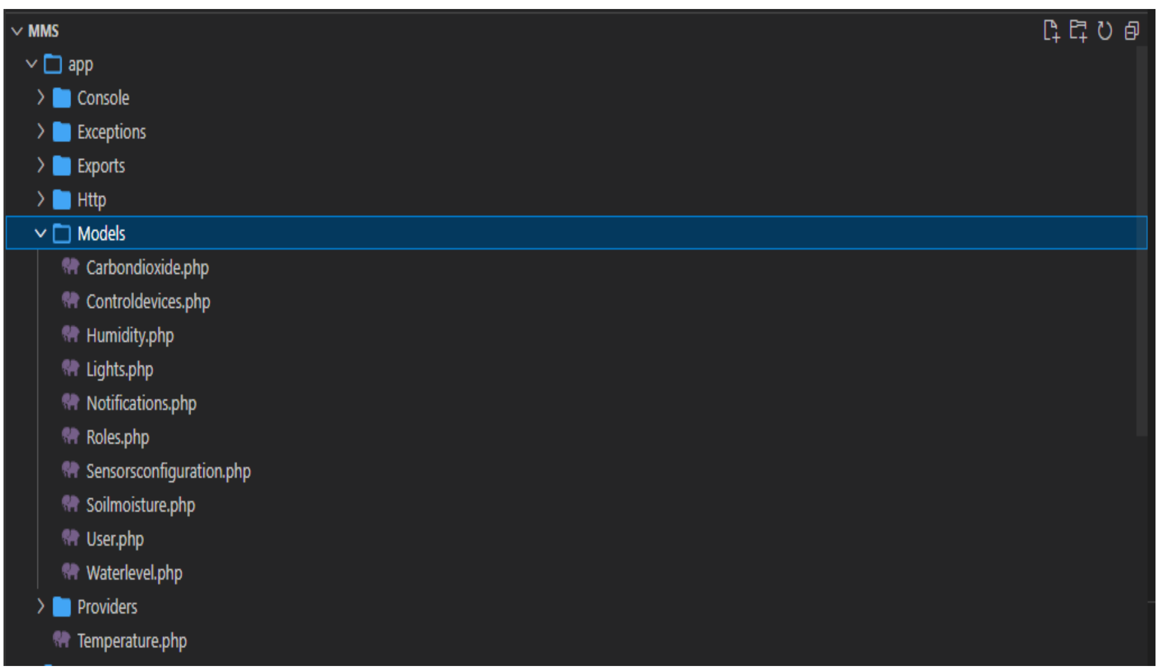

Figure 17. Models

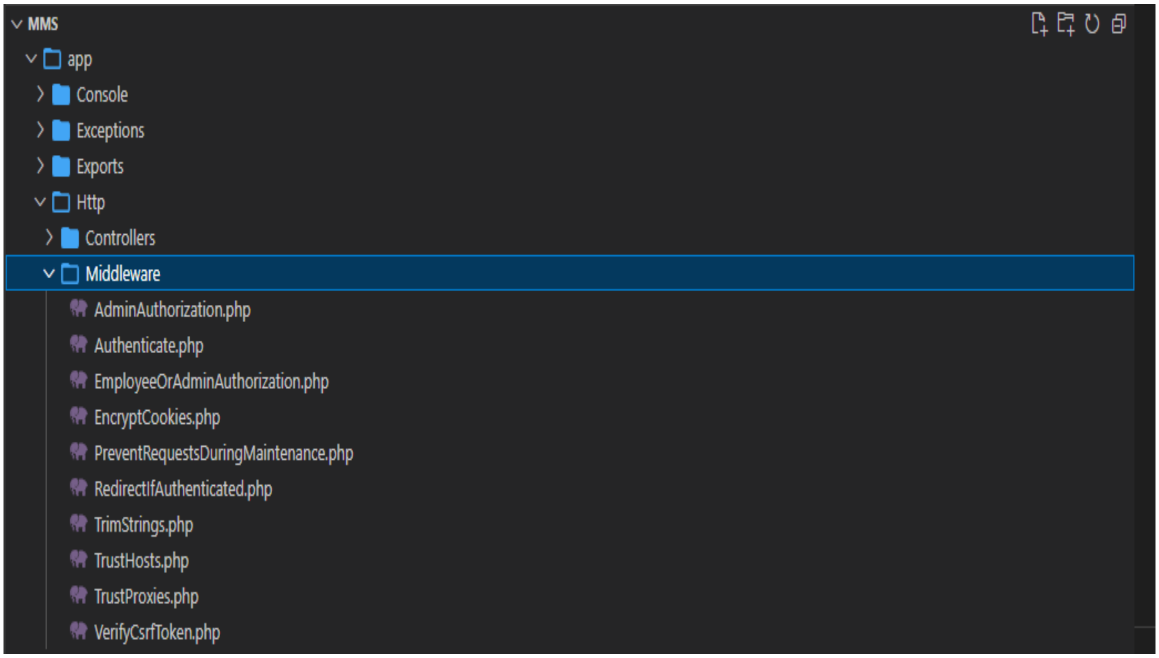

Figure 18. Middleware

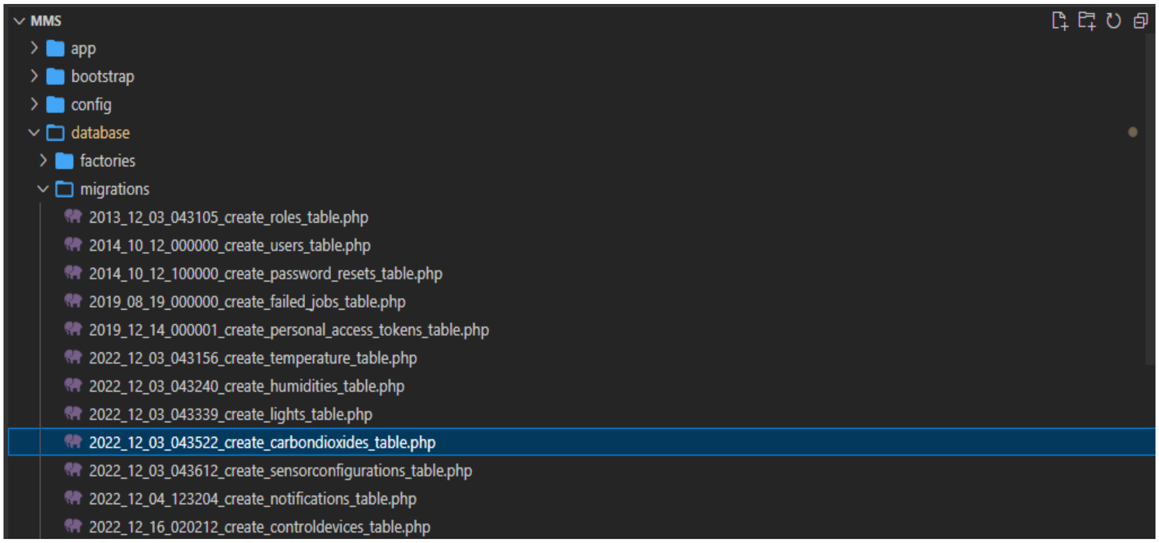

Figure 19. Database Migration

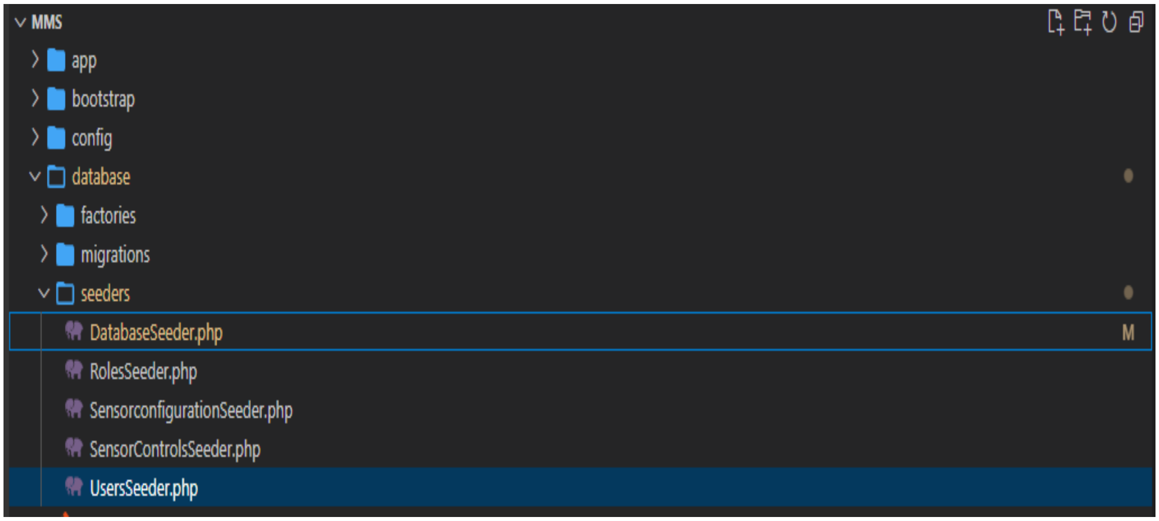

Figure 20. Database Seeder

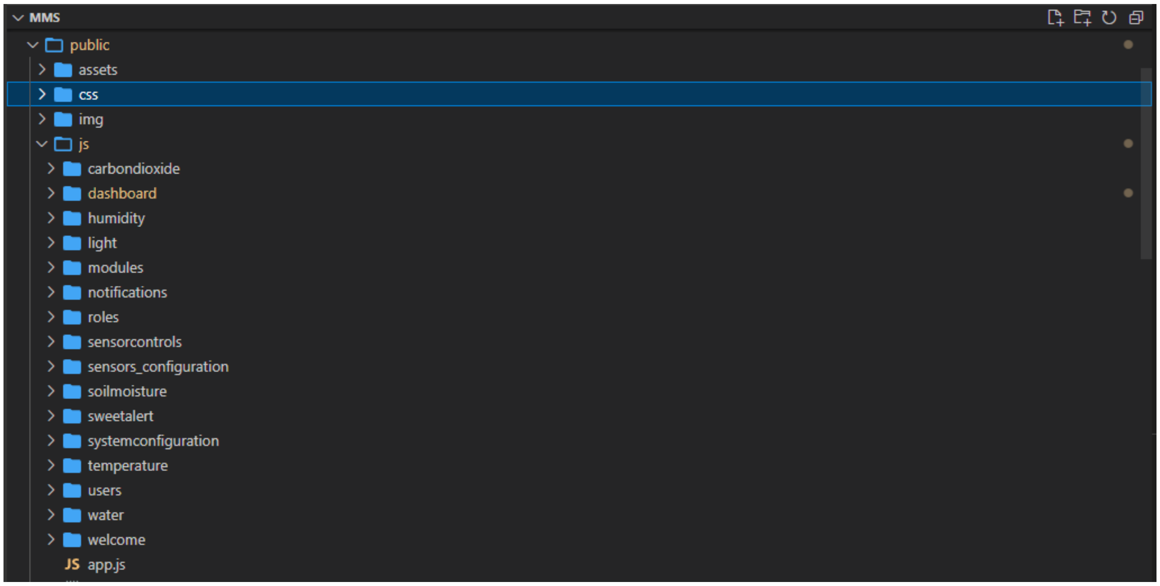

Figure 21. Javascript Files

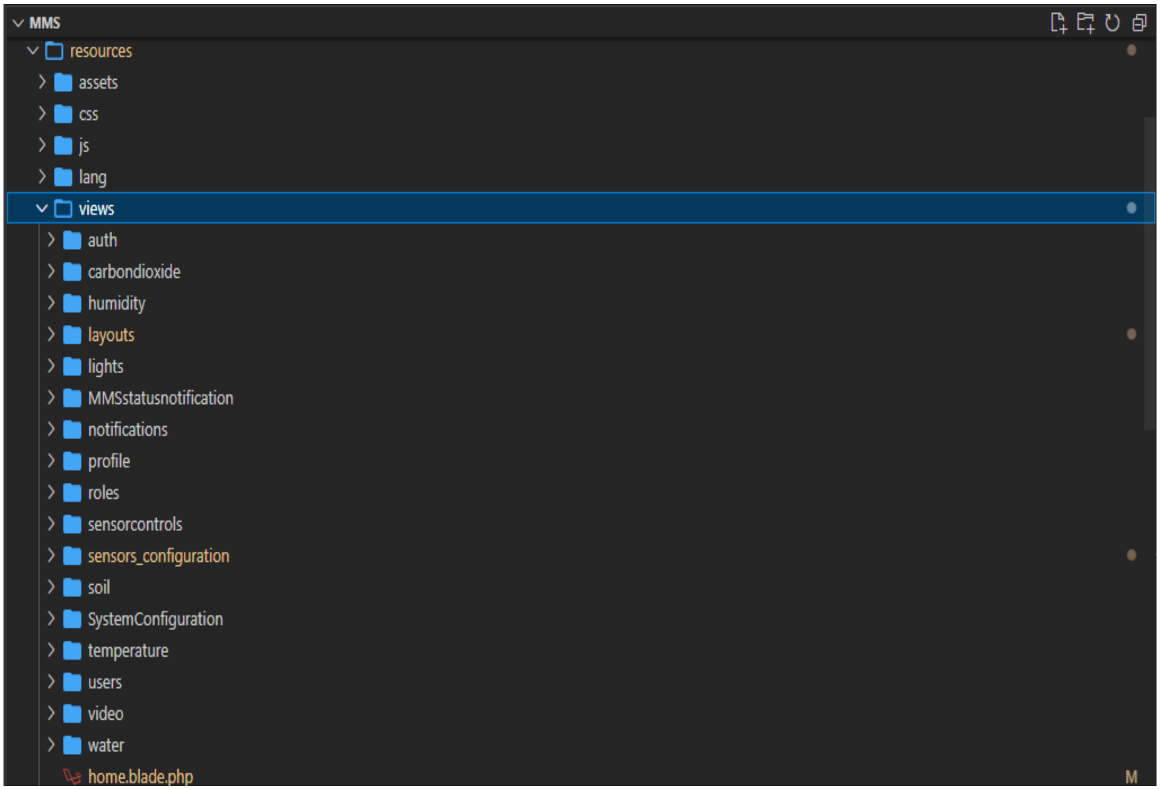

Figure 22. Views Files

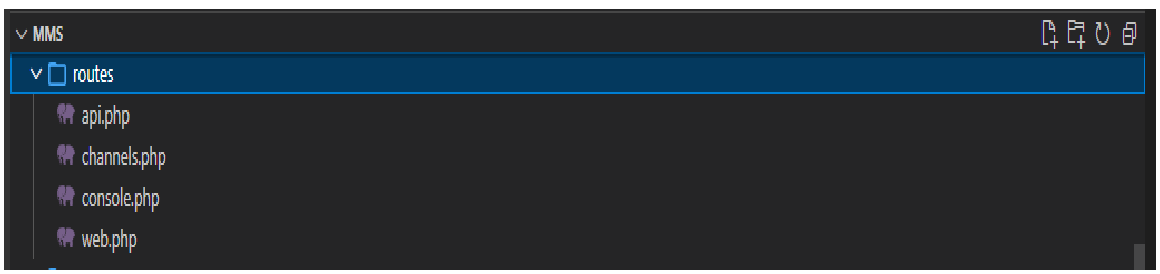

Figure 23. Router Files.

```
kopyauno.cpp
#include "MQ135.h"
#include "DHT.h"
#include <SPI.h>
#include <Ethernet.h>
byte mac[] = { 0xDE, 0xAD, 0xBE, 0xEF, 0xFE, 0xED }; //Setting MAC Address

#define DHTPIN 2
#define RLOAD 22.0
#define DHTTYPE DHT11

DHT dht(DHTPIN,DHTTYPE);
MQ135 gasSensor = MQ135(A2);

int relay = 8;
int relays = 7;
volatile byte relayState = LOW;
int gassensorPin = A2;
int gassensorValue = 0;
int soil_sensorPin = A0;
const int pResistor = A1; // Photoresistor at Arduino analog pin A0
const int ledPin=9;       // Led pin at Arduino pin 9

int soil_sensorValue = 0;
float humidityData = 0;
float temperatureData = 0;
int limit = 1000;
int photovalue = 0;
float co2amount = 0;

char server[] = "192.168.0.117";
IPAddress ip(192,168,0,120);
EthernetClient client;
```

Figure 24. Arduino Code.

In order to test the prototype that has been developed, the research used the XAMPP open-source package. It is the most popular PHP development environment not only because of being completely free and easy to install but also the Apache distribution is packed with MariaDB, PHP and Perl that are really necessary for the web developers. Figure 28. shows the XAMPP Control Panel installed in the researcher’s machine.

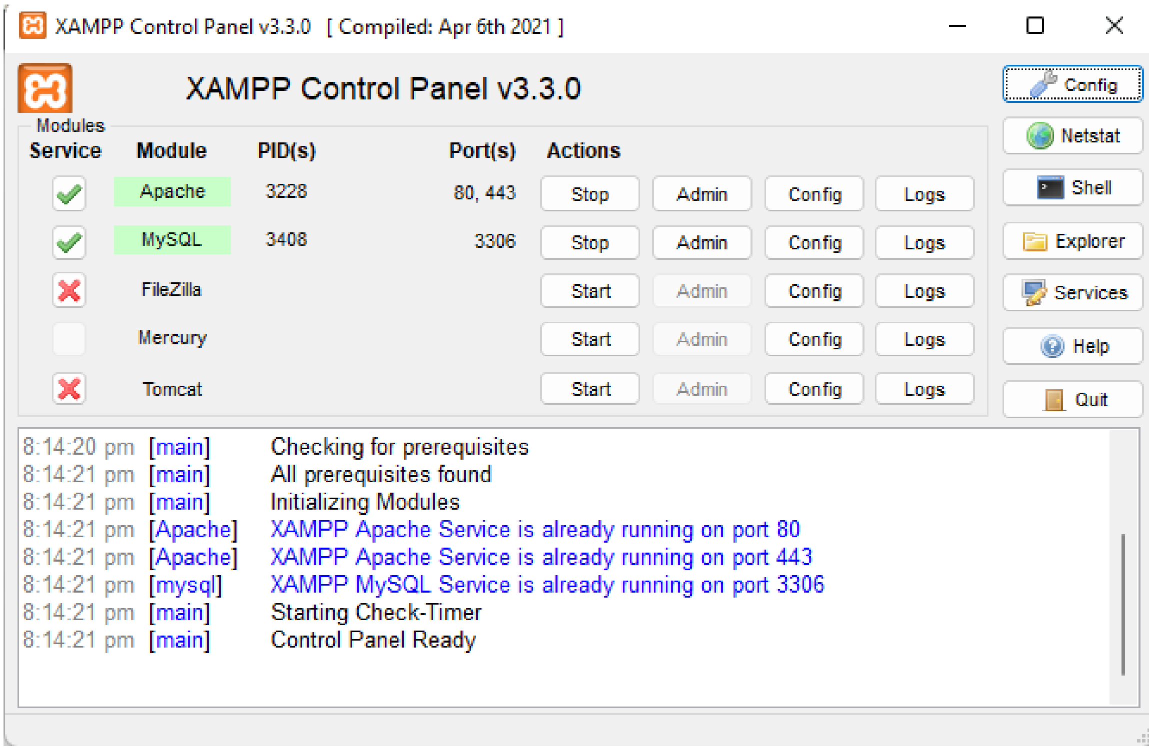

Figure 25. Xampp Control Panel.

Quality Assurance Stage

Every iteration, the Quality Assurance team was in charge of conducting quality assurance on the created work packages. The team carefully examines the system's or modules' feasibility. Most of the time, the Quality Assurance Head involves some CICT faculty members to test the system when new feature is added and have to test before the release for user-acceptance. If some bugs or error have been encountered or in case that some modules are not working, the QA team list down and immediately told it to the researcher in order to fix it immediately. Afterwards, testing and checking were done to ensure its worth.

User Acceptance Testing Stage

After the certification given by the Quality Assurance team that the Project Mushroom Monitoring System with Smart Sprinkler met its goals and objective and adequate for the usage of the research locale mushroom house.

Releasing Stage

The MMS had been installed in the hosting site named Railway Made for any language, for projects big and small. Railway is the cloud that takes the complexity out of shipping software, researcher decided to use this it because the system was been developed using Laravel framework and in railway it is easy to deploy it, it also includes databased configuration and environment variables, railway lessen the configuration time for a Laravel project it also includes the automatic deployment of the Laravel projects, the official link is mushroommonitoringsystemv2 . Along with this, the researcher also devised two users manuals (See Appendix B).

CHAPTER IV

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This chapter presents the recapitulation of this study. It presents the research problem, respondents involved, methods used, and the conclusions that were derived from the results. It also provides recommendations that could be pursued by other researchers whose main concern is the development of Mushroom Monitoring System with Smart Sprinkler.

Summary

This study applied developmental research design using Agile Software Development Methodology to develop and implement the MMS: A Web-Based Mushroom Monitoring System with Smart Sprinkler. This study has two parts namely, development and implementation phase and the assessment phase.

A real-time monitoring system became the project spark-up to initialize the development of MMS: A Mushroom Monitoring System with Smart Sprinkler to have better production and lessen the work time for farmers to monitor it manually. It measures a system's ability to extend and the effort necessary to implement the expansions. It is important in the development since the project did not only focus on a Real-Time Monitoring System but also added some devices like Arduino to have a climate control system.

This research is for the benefit of farmers, having an application of IoT in Agriculture specially in a mushroom house, farmers can easily monitor the status of the environment of the mushroom house that are suited for the mushrooms and lessen their labor time to make them more reproductive. The results of the study will be useful for future researchers with the interest in developing system with integration of Internet of Things as their basis and references that will lead for better idea for their innovation. The researchers also understood the processes in mushroom farming and how different factors can affect the growth of mushrooms.

Conclusions

The following conclusion were drawn based on the findings of this study:

1. The Agile Software Development Methodology is very effective when working with the team or group. In this study, the different stages of Agile methodology were efficiently executed which produced the MMS: A Web-Based Mushroom Monitoring System with Smart Sprinkler.
2. Constant checking of the system can be helpful for the upgradeable ideas that can improve the system more
3. The development of this system became an avenue for the research to try hardware integration using Internet of Things using Arduino Uno.
4. The developed system is very helpful to the research local especially to the owners and the staff of the mushroom houses.
5. The implementation of the system can be an instrument for the further expansion of the research locale.
6. IoT Technology was applied for the mushroom farm. The developed system was tested, The developed IoT system was considered stable humidity, temperature,

lights and Carbon dioxide data was considered reliable and accurate (if compared to the information done manually). This method can also be extended to cultivations that are made in closed areas. Weather data from the meteorological department can be used along with the sensed data to predict more information about the future which can help farmer plan accordingly and improve his livelihood. Integration of farming with IoT can make it much more efficient and profitable activity.

Recommendations

The following recommendations are made based on the aforementioned observations and conclusions:

1. Improve the alert warning system, make the web page blink defending on the alert message fetch from the sensors data to notice the user much better and quickly identify what is happening in the mushroom house or its current status.

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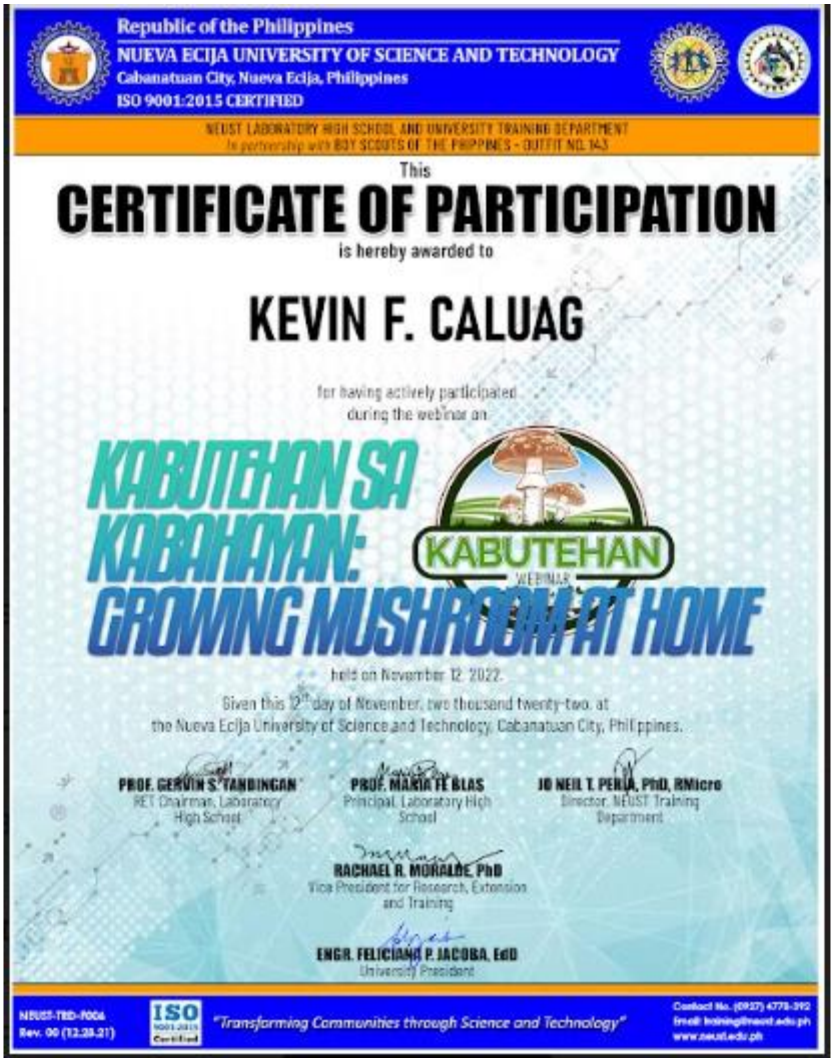
APPENDICES

Appendix A

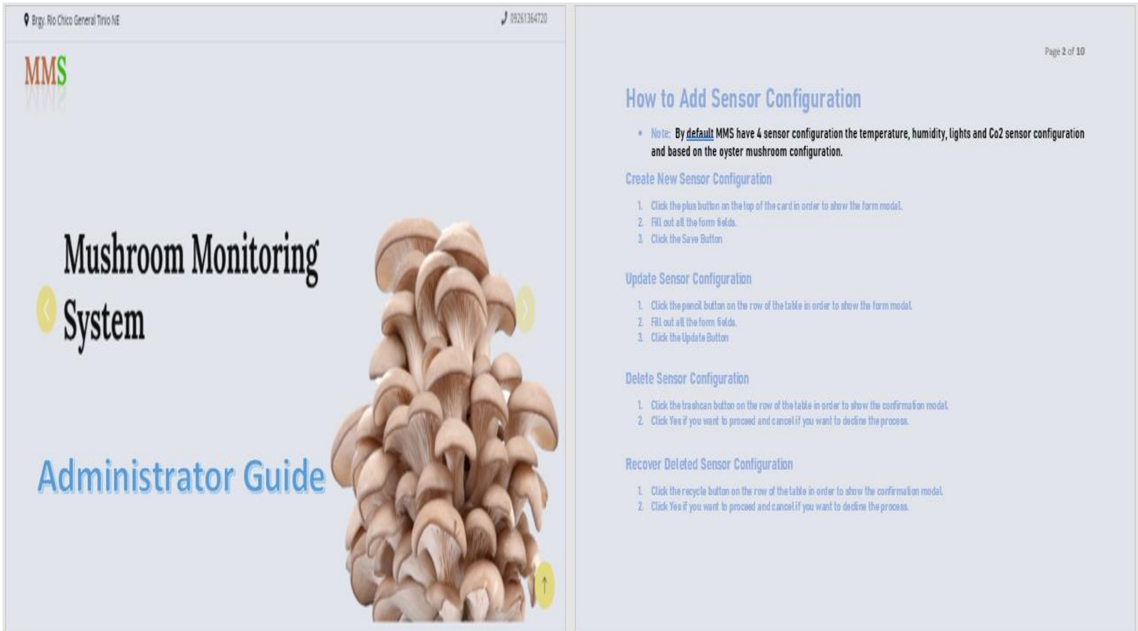
Certificate of Participation Webinar on Kabutehan sa Kabahayan:

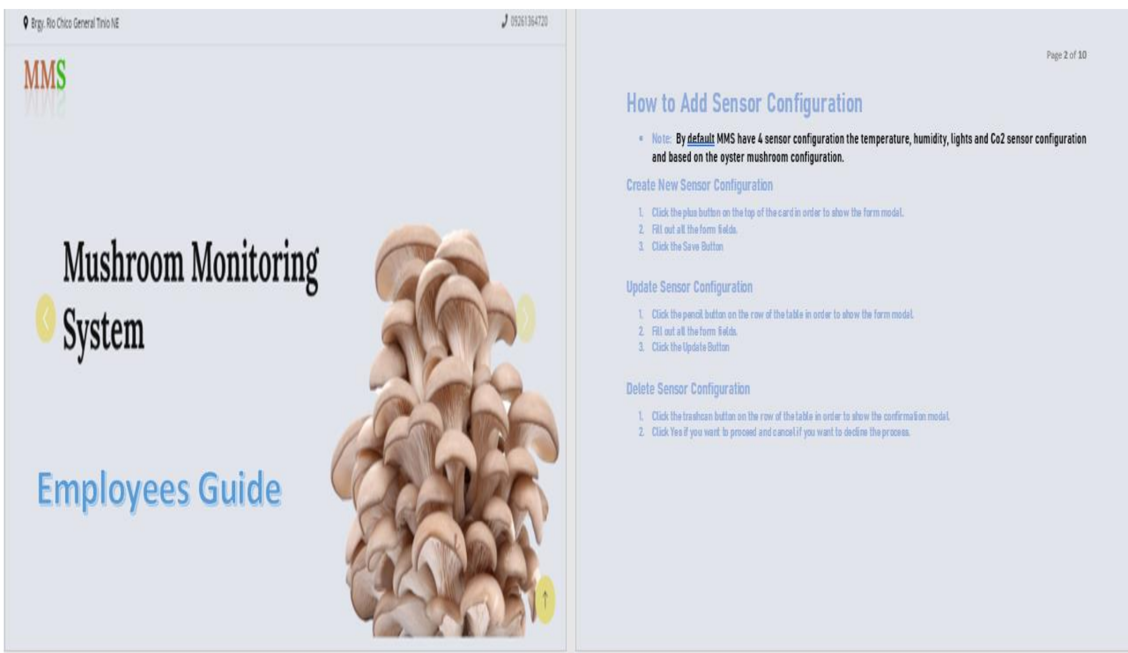
Growing Mushroom at Home



Appendix B

MMS Manual for Admin and Employees


Brgy. Rio Chico General Tinio NE
09261364720
MMS
Mushroom Monitoring System
Administrator Guide
Page 2 of 10
How to Add Sensor Configuration
Note: By default MMS have 4 sensor configuration the temperature, humidity, lights and Co2 sensor configuration and based on the oyster mushroom configuration.
Create New Sensor Configuration
1. Click the plus button on the top of the card in order to show the form modal.
2. Fill out all the form fields.
3. Click the Save Button
Update Sensor Configuration
1. Click the pencil button on the row of the table in order to show the form modal.
2. Fill out all the form fields.
3. Click the Update Button
Delete Sensor Configuration
1. Click the trashcan button on the row of the table in order to show the confirmation modal.
2. Click Yes if you want to proceed and cancel if you want to decline the process.
Recover Deleted Sensor Configuration
1. Click the recycle button on the row of the table in order to show the confirmation modal.
2. Click Yes if you want to proceed and cancel if you want to decline the process.


Brgy. Rio Chico General Tinio NE
09261364720
MMS
Mushroom Monitoring System
Employees Guide
Page 2 of 10
How to Add Sensor Configuration
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1. Click the pencil button on the row of the table in order to show the form modal.
2. Fill out all the form fields.
3. Click the Update Button
Delete Sensor Configuration
1. Click the trashcan button on the row of the table in order to show the confirmation modal.
2. Click Yes if you want to proceed and cancel if you want to decline the process.

Appendix C

Appointment of an Adviser Letter

NUEVA ECIJA UNIVERSITY OF SCIENCE AND TECHNOLOGY
PAPAYA OFF CAMPUS
Brgy. Concepcion, General Tinio, Nueva Ecija

APPOINTMENT OF AN ADVISER TO THESIS WRITER/ FEASIBILITY STUDY WRITER/CAPSTONE WRITER

September 10, 2022

DR. GERARDA R. RIVERA
College Administrator
Nueva Ecija University of Science and Technology

Thru: DR. ALBERT C. BULAWAT
College Department Head

Madam:

This is to request the appointment of JODELL R. BULACLAC, MSIT, whose signature is affixed her willingness, to serve in the preparation of my thesis/capstone/feasibility study entitled, MMS: Web-Based Mushroom Monitoring System with Smart Sprinkler (A Capstone Study).

It is understood that should there be a need for Statistician and English Reader in editing the work, it shall be my responsibility to choose anyone who can do the job.

Sincerely yours,

Kevin F. Caluag

Conforme:

Jodell R. Bulaclac, MSIT
Adviser

Approved:

____

Appendix D

LETTER TO THE CAMPUS ADMINISTRATOR

March 02, 2022
GERARDA R. RIVERA, DPA
Campus Administrator
Nueva Ecija University of Science and Technology
Papaya Off-Campus Program
General Tinio, Nueva Ecija

Thru: **ALBERT C. BULAWAT, Ed.D**
College Department Head

Dear Dr. Rivera,
Greetings of love and peace!

We, the undersigned, are the third year pursuing a degree in Bachelor of Secondary Education Major in English and are currently enrolled in SEE20 Language Education Research.

We are pleased to inform you of entitled, **"Mushroom Monitoring System with Smart Sprinkler"** in partial fulfilment of the course requirements for for the Degree Bachelor of Science in Information Technology with specialization in Web Systems Technology.

In this regard, we humbly request permission from your good office to allow us to conduct this study. Rest assured that the data to be gathered will be treated with utmost confidentiality and be used only for academic research purposes.

Thank you very much for your approval and endorsement of this request. May God continue to bless you and your family. Very respectfully yours.

The Researchers

Noted:
Jodell Bulaclac,MSIT
Research Adviser

Recommending Approval:
Christian Peña
Capstone Instructor

Approved by:
GERARDA R. RIVERA ,DPA
Campus Administrator

Appendix E

Curriculum Vitae

Contact

Phone
09261364720

Email
technowiz.kevin.caluag20@gmail.com

Address
Brgy. Nazareth General Tinio
Nueva Ecija

Education

2023
Bachelor of Science in Information Technology Major in Web System Technology
Nueva Ecija University of Science and Techonology Papaya off-campus

Expertise

- Github, Bitbucket
- Web Developer
- Mobile Application Developer
- PHP, Laravel
- Javascript, Nodejs, Composer, Angular, React
- SQL, NoSQL, Postgresql, SQlite
- CSS , Bootstrap

Kevin F. Caluag

Junior Web Developer

Innovative, task-driven professional with 3 years work experience in web development across different platforms.

Proven ability in optimizing web functionalities that improved data retrieval and workflow efficiencies

Experience

2019 - present
Technowiz Solution provider
Web Developer
- Scrum Team
- Practice agile development methodologies and work with current networking technologies
- Javascript, Nodejs, Composer
- Laravel ,PHP
- VSCode, Atom, Postman, Git bash,

2020-present
Technowiz Solution provider
Java Developer
Developed Java Application using (MVC) architecture pattern.

2021-present
Technowiz Solution provider
Mobile Application Developer
- Developed Mobile Application using Ionic Framework and Angular javascript
- Developed Mobile Application using Ionic Framework and React javascript

Education Background

Tertiary

2019 - present
Neuva Ecija University of Science and Technology papaya off-campus
Bachelor of Science in Information Technology

Secondary

2017 - 2019
Rio Chico National High School
Senior High School - General Academic Strand

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Education

2023
Bachelor of Science in Information Technology Major in Web System Technology
Nueva Ecija University of Science and Techonology Papaya off-campus

Expertise

- Github, Bitbucket
- Web Developer
- Mobile Application Developer
  PHP, Laravel
  Javascript, Nodejs, Composer, Angular, React
  SQL, NoSQL, Postgresql, SQlite
  CSS , Bootstrap

2014 - 2017
Gogon High School
Junior High School

Primary

2009 - 2014
Bogtong Elementary School

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