WATERWORKS - AI: DEVELOPMENT OF A SOLAR-POWERED AUTOMATED FERTIGATION SYSTEM WITH IRRIGATION SCHEDULING AND WATER FLOW CONTROL SYSTEM FOR FIELD CROPS UTILIZING DRIP IRRIGATION WITH MOBILE APPLICATION

A Project Study Presented to the Faculty of

Electronics Engineering Department

College of Engineering

Technological University of the Philippines

In Partial Fulfillment of the Course Requirements for the Degree of

Bachelor of Science in Electronics Engineering

Submitted by:

Barrios, Jericho D.

Bautista, Michael Paul A.

Cruz, Jireh Dawn A.

Solidarios, Marie Shaina J.

Umali, Paul Bryan C.

Adviser:

Engr. Cherry G. Pascion

August 2023

APPROVAL SHEET

This project study entitled **"WATERWORKS - AI: DEVELOPMENT OF A SOLAR-POWERED AUTOMATED FERTIGATION SYSTEM WITH IRRIGATION SCHEDULING AND WATER FLOW CONTROL SYSTEM FOR FIELD CROPS UTILIZING DRIP IRRIGATION WITH MOBILE APPLICATION"**, has been prepared and submitted by the following proponents:

Barrios, Jericho D.

Bautista, Michael Paul A.

Cruz, Jireh Dawn A.

Solidarios, Marie Shaina J.

Umali, Paul Bryan C.

In partial fulfillment of the requirements for the degree of **Bachelor of Science in Electronics Engineering** is hereby recommended for approval.

ENGR. CHERRY G. PASCION	**ENGR. JOHN PETER M. RAMOS**
Project Adviser	Panel Chair
ENGR. ROMEO L. JORDA JR.	**ENGR. EDGAR A. GALIDO**
Panel Member	Panel Member
ENGR. LEJAN ALFRED C. ENRIQUEZ	**ENGR. GILFRED ALLEN M. MADRIGAL**
Panel Member	Panel Member

Accepted and approved in partial fulfillment of the requirements for the Degree of **Bachelor of Science in Electronics Engineering**.

ENGR. TIMOTHY M. AMADO	**ENGR. NILO M. ARAGO**
Head, ECE Department	Dean, College of Engineering

ABSTRACT

Fertigation is a method of fertilizing crops in which nutrients are applied directly to the soil via irrigation systems. This strategy has grown in popularity in recent years due to the numerous benefits it delivers to farmers and producers. Many irrigation systems are inefficient owing to poor design, maintenance, or management, which can lead to water resource depletion, lower agricultural output, and higher energy expenditures. The purpose of this study is to create a solar-powered automated fertigation system for field crops employing drip irrigation with water flow and pressure control using a microcontroller, solenoid valves, and water-related sensors, as well as an irrigation scheduling system using an Android mobile application. The system is designed to reduce water consumption and prevent over-irrigation by smartly monitoring the water flow rate of the system and applying an optimal quantity of fertilizer for field crops by adjusting the flow rate and water pressure of the system. According to the findings, the average time to fill a 220-liter water container is around 34.4 minutes; pressure values fluctuate with the majority falling within a 20 percent difference, but occasional spikes indicate unstable activation of the venturi fertilizer injector; and drip irrigation increases flow duration to 24 minutes for 10,000mL, compared to 3 minutes without it. Most questions obtained a favorable grade of 3 in user evaluation, indicating agreement by the evaluators. Overall, this study demonstrates the potential of automated-fertigation systems as long-term precision agricultural solutions and a chance of optimizing activities while reducing resource waste.

ACKNOWLEDGMENT

The completion of this thesis represents the culmination of the determination, countless hours of hard work, and numerous sleepless nights of the proponents of this study. It stands as a significant milestone in their journey as college students. This research would not have been possible without the collective efforts and support of several individuals. The researchers would like to express their deepest gratitude and appreciation to the following:

First and foremost, their sincere thanks to God Almighty, for all the blessings and for giving the researchers the strength, knowledge, wisdom, and guidance in completing this research.

The proponents are grateful to their Project Study Adviser, Engr. Cherry G. Pascion, whose guidance, knowledge, and consistent support have been instrumental in shaping and improving the direction and quality of this research. They are also thankful to their Project Study Professor and Dean of the College of Engineering, Engr. Nilo M. Arago, for sharing his time, effort, knowledge, and experience in coming up with this study.

The proponents are immensely grateful to the faculty members of the Electronics Engineering Department their beloved panelists, for providing invaluable suggestions and recommendations. Their wisdom, expertise, and commitment to academic excellence have been truly inspiring.

The proponents would also like to extend their heartfelt thanks to the participants who willingly shared their time, effort, experiences, and perspectives, contributing

immensely to the data collection process. Their willingness to engage in our project study has provided invaluable insights and has helped to improve the findings presented in this study.

The researchers would also like to express their gratitude to the Cruz, De Joya, and Dela Fuente families for their continuous support to the researchers by providing food, assistance, and shelter during their stay in the deployment area in Bustos, Bulacan.

Lastly, the researchers would like to express their gratitude to their own families, friends, and fellow students who have offered their unwavering support, constructive feedback, and encouragement throughout this challenging journey. They also acknowledge the immeasurable support and sacrifices made by their families. Their love, understanding, and encouragement have served as the cornerstone of our pursuit of higher education. We are truly grateful for their belief in our abilities and their constant support.

Team WaterGuarden

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ANNEX

CHAPTER 1

THE PROBLEM AND ITS SETTING

This chapter presents an introduction to the study and an overview of its significance. This chapter includes the scope and limitation of the study and the general and specific objectives.

1.1 Introduction

Irrigation is one important aspect of a crop to grow well. Just like in the Philippines, one of many countries that primarily depends on its agricultural sector, watering crops is essential for bountiful yield. However, crops need more than just watering to ensure their growth. Crops also need fertilizers that provide extra nutrients to grow with high quality.

The method by which fertilizers are delivered to the plants in conjunction with watering them is called fertigation. This method is one of the gradually recognized and practiced techniques in agriculture in modern times. Because of this process, farmers save time in their work because watering and fertilizing are done simultaneously. It can increase productivity and make the most of their resources.

The production of the crops was based on the proper water supply and fertilizer being put or given to the crops. Inadequate nutrition input management has resulted in a significant restraint on human health and the environment. The excessive utilization of nitrogen and phosphorus fertilizers has polluted groundwater [1]. The adverse effects of misuse of fertilizers, it implies a negative impact not only on the plant or crop itself but also on those surrounding it.

To solve the problems mentioned, creating an automated system is necessary. Automating a system is adapting a complicated, autonomous approach to function automatically using rules stored in the program. In this case, the system required is an automated fertigation system. An automated fertigation system is a system that can reduce water and fertilizer wasted due to manual use of them to avoid overusing which causes problems like the ones mentioned above.

1.2 Background of the Study

21st-century agriculture shall face a lot of difficulties in food and fiber production to feed the increasing global population when the year 2050 comes. The security of water resources, energy sources, and sources of food is crucial for an economy that aims to be long-term sustainable. The agricultural sector consumes vast amounts of water and irrigation uses approximately 70% of the water coming from the underground and from the rivers. It is always considered that agriculture is one of the major consumers of water resources and still needs more to be efficient, most especially during times of parched and semi-parched conditions [2].

The fertigation method allows the distribution of fertilizers to crops in the right amount and proper time for a certain crop growth level. People who wish to insert chemicals have various equipment to choose from, the pressure difference or batch containers, bladder containers, equipment, and pumps with positive displacement are all examples. The most important aspect of the technique of irrigation is duration, and a vital component of the fertigation process is achieving the right balance between maximum crop development and optimum water consumption. The objective is to accomplish sustainable

farming regarding ecological and environmental compatibility, as well as economic compatibility; an essential component in achieving this goal is the proper use of multiple inputs such as nutrients, water, protection for plant products, and so on, into agricultural manufacturing processes [3]. The technique of fertigation allows the process of delivering the water and fertilizers directly to the root area of the crops. Even this fertigation system has the constraints of excess concentration of fertilizers which is done by manually turning on & off the water pump [4].

The automation of the process of fertigation was suggested for this system to automatically turns on and off the motor for the right mixing of fertilizer and lets it flow through the watering system. Hence, the mixture of the fertilizer and water is delivered to the plants which leads for it to better growth [5]. The system was fully powered by solar energy and has been tested on its efficiency in mixing fertilizer and at the same time monitoring all the key parameters of the system. Automation in the irrigation system is present today in the country in which the water can be delivered to the lands automatically when there is a need for it.

1.3 Research Gap

The proposed idea introduces a state-of-the-art, eco-friendly system that utilizes solar power to automate the process of fertigation for field crops. This innovative system incorporates a sophisticated irrigation scheduling mechanism, along with a meticulously engineered water flow and pressure control system. Notably, the system seamlessly integrates with a mobile application through Wi-Fi connectivity, enabling effortless monitoring and management.

A noteworthy advantage of this system is its ability to accurately determine and administer the optimal amount of fertilizer within the fertigation system for field crops. This precision is achieved through precise measurement and regulation of the flow rate from the fertigation system. However, it is important to acknowledge that the implementation of this system may present certain challenges due to the complexity of its functionalities and programming intricacies.

1.4 Research Objectives

1.4.1 General Objective

To develop an in-situ solar-powered automated fertigation system that will automate the process of applying organic liquid fertilizer within an irrigation system utilizing the Venturi effect along with a partnered mobile application for irrigation scheduling and system monitoring.

1.4.2 Specific Objectives

1. To develop a solar-powered automated fertigation system utilizing water-related sensors and solenoid valves using microcontrollers as sensor node.
2. To construct a water source system that mainly focuses on deep-well for the automated fertigation system.
3. To create a database and an Android mobile application for irrigation scheduling and monitoring of the automated fertigation system.
4. To test and evaluate the functionality of the system through simulations and on-site field testing.

1.5 Significance of the Study

This study would be essential to local farmers by significantly improving water and nutrient usage. Solar-powered automated fertigation systems that feature diverse parameters are essential to those who have been utilizing the manual method of fertilization and irrigation for years now. This technology is also beneficial for crop cultivation as it maintains adequate irrigation with fertilizers and check on the nutrients and work on itself automatically in case there is a shift in natural occurrences. Also, the use of automated fertigation helps produce better crop quality as it distributes the precise number of micronutrients and delivers higher yields.

This study is classified under Agriculture, Aquatic, and Natural Resources (AANR) of the Department of Science and Technology's (DOST) Harmonized National Research and Development Agenda (HRNDA). The main objective of this section addresses Cultural Management Practices for soil health, nutrient, and water management.

On top of that, this study shall be essential to the Sustainable Development Goals (SDGs) which Goal 6: Clean Water and Sanitation and Goal 9: Industry, Innovation, and Infrastructure which the target is to increase the efficiency of water usage in many activities and improve scientific investigation and industrial sector technical capacities in the world, particularly of those countries that are still developing.

1.6 Scope and Limitations

The project focused solely on constructing a solar-powered automatic fertigation system with a device and mobile application that automatically distributes water injected with organic liquid fertilizer using a drip irrigation system to ensure even time distribution of water and fertilizer across the crops. A microcontroller shall be utilized to control the right amount of water to release. The system also uses solar panels to harness solar energy which intends to be the system's main power source. Solenoid valves shall also be utilized to control the water flowing through the system. The mobile application developed for the users is able to set a schedule of the process they want either for irrigation or fertigation. The system was developed and deployed in a farm located in Bustos, Bulacan.

The project is limited to being used and tested for field crops focusing primarily on fertigation and control of water flow. The preservation of the system still needs human supervision to keep the processes on course to establish the right amount of water enough for irrigation. The scheduling of the process is also still in need of human intervention to be able to perform the operation. The system is also limited to waiting for the current process to finish. There is no switch that can stop this process in the hardware itself or in the mobile application. The only turn-off switch it has is for stopping the entire system and not just its process.

1.7 Definition of Terms

Drip irrigation – An irrigation technique that directly delivers the water to the roots of the planted crops. This method is said to be the least water-consuming irrigation technique.

Fertigation – It is a farming method wherein fertilizers were incorporated into the irrigation systems to make the direct distribution of nutrients to the crops possible.

Water Flow Rate – It is the measurement of the volume of water passing through a system at a particular moment, as detected by the system's flow sensor.

Water Level – It refers to the distance downwards of the water in the water container of the system. It is the perpendicular distance of the surface of the water to the reference point measured by the ultrasonic level sensor.

Water Pressure – It is the force of the water that enters the system. It is measured by two pressure sensors placed in the inlet and outlet of the fertigation system.

Venturi Effect – A phenomenon that occurs when the amount of differential pressure between the inlet and outlet of a venturi tube allows a substance outside of the tube to be added to the mixture.

CHAPTER 2

REVIEW OF RELATED LITERATURE

This chapter presents the summary of the different existing literatures and research studies that are related to the study. This will also provide general overview and a theoretical foundation for the study.

2.1 Automated Irrigation System

Numerous projects and studies related to automated irrigation systems focus on developing a technology that can minimize or lessen water usage and limit the need for manual supervision. Manual irrigation method today needs onsite supervision at a specific time in the day. This kind of method also leads to water loss or water waste on the farm. This could possibly lessen crop production as it can make the plants dry and make their growth slower. Farmers, when their system of application of fertilizers is manual, they may lack and overdo it, which will result in a decrease in the production of crops. These problems can be solved by incorporating remote and automatic drip irrigation system [6]. A study in a smart irrigation system using IoT presents an efficient, low-cost, and simple automated irrigation system that lowers the maintenance cost and is convenient to operate. The smart irrigation system is suitable for agricultural production while being advanced and less costly [7]. The purpose is to lessen or fully avoid human involvement and make the system simple to operate and convenient for the farmers to use, hence, the development of irrigation systems utilizing IoT allowed the user to view the status of the operation on the farm by using a monitoring and control system [8]. A further study explained that

through the system that was developed, the farmers are not required to supervise the field on site as these systems were already automatic and worked by themselves when needed. Despite this, developers have also dealt with making a manual override in case of failure happening to the system [9].

Agriculture is important for progressing countries. 85% of global freshwater is being used for agriculture due to increasing population and food demand. Having efficient water management in dry and semi-dry areas is crucial and the solution for this is having an automated irrigation system that will optimize the use of water for watering crops. An automated irrigation system avoids over and under-irrigation [10]. Another study focused on providing the development of framework design in developed places where crop growing spaces are constrained. The researchers provided local control for its decision-making system, sensors, and actuators, and a centralized control was integrated into the cloud where the data will be stored when received. Hence, this allows the users to make an analysis and system monitoring by accessing the internet [11].

A study on the development of an automated irrigation system that remotely uses wireless sensors and decision-making technologies to gather data on its environmental parameters on the field. The gathered data of the sensors was transferred to the cloud which makes it one of the Internet of Things technologies. Hence, it is feasible to enhance the productivity, efficiency, and precision of the crop growing which can result in an increase in profits [12]. One study in India aims to create an automated irrigation device that is based on a microcontroller with integrated sensors on it. The system uses drip irrigation which is said to be the most efficient irrigation method. In this method, the water drops directly at the roots of the crops. The employed automated irrigation system is consisting

of two parts, the control, and sensing parts. The first is the control unit which is made mainly of the microcontroller that leads the operation to happen, and the second part is the sensing unit wherein it made from various sensors [13].

To summarize, the automated irrigation systems developed by different researchers were created as a technology to operate irrigation structures so that the flow of water changes when needed. Consistently, the systems featured parameters even when users are not on-site, they can stay informed and involved in the success of the crops with the automated irrigation.

Table 2.1 Different Automated Irrigation System Related Studies

Author	Year	Title	Relevant Findings	Relationship to the Study
S. MuthuKumar M. Naveenraja V. NaveenKumar Associate Prof. Dr. S. RajaRanganathan		Sensor-Based Automatic Fertigation System	Development of an irrigation system.	Using of drip irrigation method in the irrigation process.
Engineering, E., Nadu, T., Parathraju, P., Dinesh, G., Anandhakumar, N., Engineering, E., & Nadu, T.	2018	Automated Solar Powered Irrigation	Solar-powered water pump A moisture sensor-controlled automatic water flow	Partnered with a mobile application for monitoring
Pawar, Swapnali B.	2018	IRJET- Smart Irrigation System Using IOT And Raspberry Pi	A sensor used to measure the water level	Partnered with mobile application. Water management
Shoba Krishnan, Kalyani Lakkanige, Ragini Ananthakrishnan,	2020	Automated Irrigation System	Using solenoid valve	Monitor the field automatically Automatic irrigation system

Dhaneesh Virwani, V. L.				
Nandhini, R., Poovizhi, S., Jose, P., Ranjitha, R., & Dr.S.Anila	2017	Arduino Based Smart Irrigation System Using IOT	Using of Arduino microcontroller	Can access the server anywhere and anytime Automatic switching on and off water pump
Karpagam, J., Merlin, I. I., Bavithra, P., & Kousalya, J.	2020	Smart Irrigation System Using IoT	Using of Arduino microcontroller	Allows to monitor and control anywhere
Sagar, S. V., Kumar, G. R., Xavier, L. X. T., Sivakumar, S., & Durai, R. B.	2017	SISFAT: Smart Irrigation System with Flood Avoidance Technique	Using solar cell Using Arduino microcontroller Water level sensor	Automatic irrigation system
Li, W., Awais, M., Ru, W., Shi, W., Ajmal, M., Uddin, S., & Liu, C.	2020	Review of Sensor Network-Based Irrigation Systems Using IoT and Remote Sensing	Usage of microcontroller Water sensor	Automatic water flow system
Lorvanleuang, S., & Zhao, Y.	2018	Automatic Irrigation System Using Android	Using of relay module	Automatic irrigation is implemented Partnered with mobile application
Kulkarni, S., & Mulagund, R.	2016	Automatic Irrigation System Using IOT	Arduino Microcontroller is used Using of relay module	Automatic irrigation is implemented Partnered with mobile application
Rajendranath, U. N. V. P., & Berlin Hency, V.	2015	Implementation of An Automated Irrigation System: Smart Irrigation System	This study also used Arduino uno	Live monitoring Automatic distribution of water
Ahmed, A., & Rawal, S.	2017	IOT based Smart Irrigation System Cite this paper IOT based	Used Arduino Uno for this study	Automatic irrigation system

		Smart Irrigation System		
Palconit, M. G. B., Macachor, E. B., Notarte, M. P., Molejon, W. L., Visitacion, A., Rosales, M., & Dadios, E	2020	IoT-Based Precision Irrigation System for Eggplant and Tomato	Used a microcontroller (Arduino Uno)	Implementing automatic irrigation Using of drip irrigation system
Vaishali, S., Suraj, S., Vignesh, G., Dhivya, S., & Udhayakumar, S.	2018	Mobile Integrated Smart Irrigation Management and Monitoring System Using IOT	Sensors are the device which converts the physical parameter	Automatic water irrigation system Can be monitored anywhere using mobile application
Kansara, K., Zaveri, V., Shah, S., Delwadkar, S., & Jani, K.	2015	Sensor based Automated Irrigation System with IOT: A Technical Review	Monitors the water level through water level sensor	Automatic water irrigation system Partnered with Mobile Application
Khand, Q. U., & Barket, A. R.	2015	Smart Water Distribution for Irrigation System Smart Water Distribution for Irrigation System (SWDIS)	A microcontroller is used to keep track of everything.	Automatic water distribution

2.2 Automated Fertigation System

A handful of related studies on automated fertigation systems focused on dealing with the general problems farmers frequently encounter, especially in input wastages and low production due to inaccurate types of fertilizers used by the farmers. A paper introduced the use of the fertigation system as a solution to the difficulties of the farmers by designing an automated fertigation system utilizing IoT [14]. Fertigation is one of the

many agricultural methods used in farming today. This technique is popular for being efficient and the best way of using its resources resulting to a high productivity [15]. A study on automated irrigation and fertigation system applying sensing technology is designed to fit both large and small-scale applications. The project implements automation in both the irrigation and fertigation processes. The benefits of this work are given to the farmers where their intervention is not much needed as their previous method. Farmers can monitor the irrigation process through their mobile phones. The system is designed to reduce human labor and do not need to farm every day and water their crops manually. The reduction of human intervention is due to the proper method of automating the irrigation process while applying the Internet of Things to have high, effective, and secured crop production and ensure the efficient use of water resources [16].

Another study whose research goal was to develop a mobile application using Android Studio software. Using the developed technology, the users were able to determine the exact amount of fertilizer to be applied per liter of water in the fertigation tanks. It was also partnered with a mobile application that operated automatically after the configuration of the data had been collected [17]. Comparatively, water-soluble fertilizers were utilized in a study that focused on verifying the most suitable solution for fertigation. Similar to other studies, it is also given that fertigation has many benefits to its users like having high and quality yield, efficiency in utilizing its resources, safety in the environment, and being flexible in its operations [18].

Fertigation is a technique that allows the delivery of soluble fertilizers directly to the crops utilizing the irrigation system. The implemented system uses drip irrigation to distribute fertilizers to the vegetables directly [19]. Drip irrigation devices must be

implemented to conserve and sustain soil and water resources. According to a study that incorporates drip irrigation because of its advantages, it is said to save 30-50 percent of water and can irrigate more crops efficiently. Drip irrigation is a technique of pressurized irrigation in which water is equally dripped directly to the roots of the crop along with fertilizer that will help the crops to grow well [20]. Another study included an irrigation and fertilizer distributor system. The water is regulated by a controller and the watering is terminated when the desired amount of water is reached by the system. The fertilizer supplier system delivers fertilizer directly to the plants. Based on the results of the study, by meeting the right water and fertilizer values, the productivity of the farm in growing crops increased [21].

To summarize, the automated fertigation systems developed by the researchers were created to help local farmers for them to increase crop yield and crop quality by automatically releasing water mixed with fertilizer based on the gathered data by the researchers to ensure evenly distributed nutrients in the soil.

Table 2.2 Different Automated Fertigation System Related Studies

Author	Year	Title	Relevant Findings	Relationship to the Study
Ahmed, O. M. E., Osman, A. A., & Awadalkarim, S. D.	2018	A Design of an Automated Fertigation System Using IoT	Fertigation system based on IoT	Utilization of moisture sensor
Thirunavuakkarasu, C. J., Bhaskar, A., & Penujuru, A.	2017	Automated Fertigation System for Utilization of Fertilizer and Water.	Automated fertigation system Farm automation	Maintain the right ratio of NPK nutrients and give it to plants along with irrigation.

Raut, R., Varma, H., Mulla, C., & Pawar, V. R.	2018	Soil Monitoring, Fertigation, and Irrigation System Using IoT for Agricultural Application	Fertilizer dispensing irrigation Emailing through IoT	Maintaining the right amount of NPK nutrients to be used in fertigation system
Pérez-Castro, A., Sánchez-Molina, J. A., Castilla, M., Sánchez-Moreno, J., Moreno-Úbeda, J. C., & Magán, J. J.	2017	cFertigUAL: A Fertigation Management App for Greenhouse Vegetable Crops	Automated fertigation system with mobile application using IoT	Using a mobile application to control the fertigation process.
Shukla, M., Chinchmalatpure, A., Prasad, I., & Kumar, S.	2018	Fertigation Modern Technique of Fertilizer Application	Fertigation System Drip Irrigation	Usage of drip irrigation will get a higher fertilizer use efficiently as well as increasing the crop fields.
Mahyuzie Jenal, H. Z. N.	2021	Automated Irrigation and Fertigation System Applying Sensing Technology	Automated fertigation using IoT Mobile Application	Usage of automated fertigation systems increase production efficiency.
Mohidem, N. A., Norasma, N., & Ya, C.	2021	Development of the Automated Fertigation System using Mobile Apps	Automated Fertigation control system Fertilizers Mobile Application	The required amount of fertilizer and feeding time will be determined based on the data collected from the automated system.
Mohamad Nursholehan, N. Z. M.	2021	Dripper Irrigation Monitoring System for Chili Fertigation using EC-GSM	Usage of Arduino Microcontroller Drip Irrigation	With the use of drip irrigation, it is very important to maintain the dripper and monitor if it is clogged.

M.F., M. F., Nordin, M. K., Mohd Yassin, A. I., & Md Tahir, N.	2021	Automated Fertilizer Mixer System for Fertigation Farming. Journal of Electrical & Electronic Systems Research	Usage of Arduino microcontroller Automated fertigation system	Arduino microcontroller is used to operate the system in mixing and distributing nutrients in soil.
Muthukumar, S., Naveenraja, M., Naveenkumar, V., & Rajaranganathan, S.	2019	Sensor Based Automatic Fertigation System	Fertigation system	Using an automated fertigation system will increase the productivity of the crop and improve the texture of soil.
Çetin, Ö., & Akalp, E.	2019	Efficient Use of Water and Fertilizers in Irrigated Agriculture: Drip Irrigation and Fertigation	Efficiency on using nutrients and water Drip irrigation	Using drip irrigation will save irrigation water and increase crop yields and crop quality.
Bell, S., Koc, A. B., Maja, J. M., Payero, J., Khalilian, A., & Marshall, M.	2022	Development of an Automated Linear Move Fertigation System for Cotton Using Active Remote Sensing	Use of microcontroller	Automated fertigation system Usage of microcontroller
Zhang, Z., Chen, C., Li, H., & Xia, H.	2020	Design, Development, And Performance Evaluation of a Fertigation Device for Distributing Solid Fertilizer	Fertilization Usage of pressure differential tank	Usage of fertigation system
Akshay Y. Kachor, Ketaki Ghodinde	2019	Design of microcontroller based agribot for fertigation and plantation	Microcontroller Water management Automated system	Usage of automated fertigation system

Ahmed, O. M. E., Osman, A. A., & Awadalkarim, S. D.	2018	A Design of an Automated Fertigation System Using IoT	Fertigation system based on IoT	Utilization of moisture sensor
Khand, Q. U., & Barket, A. R.	2015	Smart Water Distribution for Irrigation System Smart Water Distribution for Irrigation System (SWDIS)	A microcontroller is used to keep track of everything.	Automatic water distribution

2.3 Solar-Powered Fertigation System

Numerous studies developed a solar-powered fertigation system utilizing its major component, solar power energy, for the advantage to be adaptive to weather conditions and its affordable design with concentrated manual interventions and overcoming the difficulties of accelerated growth at the same time. A paper focused on solar-powered fertigation dependent on a low-cost wireless sensor network (WSN), almost self-sufficient from the point of view of the energy, that is supervised and transferred locally or to the on-cloud software platform. According to the results, the system prototype successfully detected its environmental parameters for checking the growth of the crops in the field directly and for giving farmers access to the decision to the growth stage of the cultivated crops. The developed automated fertigation system further explained the needs of crops in water, its collected previous data, and its current obtained data. By considering what the soil and the plant's needs, the system was able to achieve efficient usage of water and fertilizers [22].

Another study described a design of a remotely controlled solar-powered fertigation system that is integrated with up-to-date technologies in lined with the needs of the agricultural industry, ending up in minimal impact on the environment all thanks to the conservation of water and usage of fertilizer and in harnessing solar energy to power the electronic components and sensors of the wireless sensor network (WSN) [23]. For another study, a predefined electrical conductivity value was used as an input that controlled all the automatic operations in cultivation by applying a fertigation system. The established system is totally powered and run by a solar-powered based system and tested on its efficiency to control the fertilizer mixing process and distributed nutrient solutions based on the crop growth amount and at the same time monitor all key parameters in the fertigation system. This project was developed and tested to give a low-priced solution for the irrigation and fertilizer mixing precise control [24].

Solar energy has been employed in a specific investigation to replace fossil fuels such as diesel and petrol in the process of spraying fertilizers and pesticides. Solar sprayers have demonstrated greater efficiency compared to their fossil fuel counterparts. To facilitate this, a solar panel was linked to a battery via a charge controller, which served the crucial function of regulating voltage. This regulation was significant in safeguarding the battery against potential harm caused by overcharging [25].

Furthermore, a study proposed to do a real-world application of a completely automatic solar-powered irrigation and fertigation system which utilized a variety of sensors such as ultrasonic and moisture sensors that detected the condition of the fertilizer container. In the end, the operation was considered acceptable, and the tested system was also efficient to use by the local farmers who had an ambition of improving their

agricultural sector. Another element this study also refined were the improvement in the income of the country by improving yield and lowering charges from electricity intake [26].

Upon skimming the related literature on solar-powered fertigation systems, almost every study was able to provide a low-cost innovation despite using solar-powered devices and a variety of sensors utilized in creating automated irrigation and fertilizer distribution at the same time. They have also monitored and analyzed how this technology helped in overcoming hardships in crop growth, even the distribution of fertilizer to every plant, and most especially the crop yield and production rate it raised compared to the conventional method.

Table 2.3 Different Studies Related to Solar-Powered Fertigation System

Author	Year	Title	Relevant Findings	Relationship to the Study
Anto Bennet, M., Venkatraman, S., Devandra Kumar, L., Anish, E., & Abinesh, V. X.	2016	Solar Powered Automated Fertigation Control System for Terrace Farming Using Zigbee	Renewable solar power	Low-cost design Reduced manual operation
Ahmad, U., Alvino, A., & Marino, S.	2022	Solar Fertigation: A Sustainable and Smart IoT-Based Irrigation and Fertilization System for Efficient Water and Nutrient Management	Utilization of on-cloud software platform	Usage of liquid fertilizers Automated distribution
Visconti, P., de Fazio, R., Primiceri, P.,	2020	A Solar-Powered Fertigation System Based on Low-Cost	Sensors of the WSN	Remotely managed solar-powered system

Cafagna, D., Strazzella, S., & Giannoccaro, N. I.		Wireless Sensor Network Remotely Controlled by Farmer for Irrigation Cycles and Crops Growth Optimization		
Salih, J. E. M., Adom, A. H., & Shaakaf, A. Y. M.	2012	Solar Powered Automated Fertigation Control System for Cucumis Melo L. Cultivation in Green House	Usage of predefined electrical conductivity value	Control system for the nutrient mixing process and injected nutrient solutions
Mallan, S., Karthick, K., Cheran, B., & Karthickram, S.	2021	Smart Solar Powered Agricultural Fertilizer Sprayer	Innovation of solar sprayers	Usage of solar power energy
Khairul Zaman, M. A.	2020	Design and Implementation of Lab Scale Automated Solar Powered Irrigation and Fertigation System	Utilization of ultrasonic and moisture sensors	The aim to reduce cost from electricity consumption

CHAPTER 3

METHODOLOGY

This chapter presents the methodologies and procedures used in developing and implementing the system. The proponents also included the research process flow in constructing the whole system.

3.1 Research Design

3.1.1 Input-Process-Output (IPO)

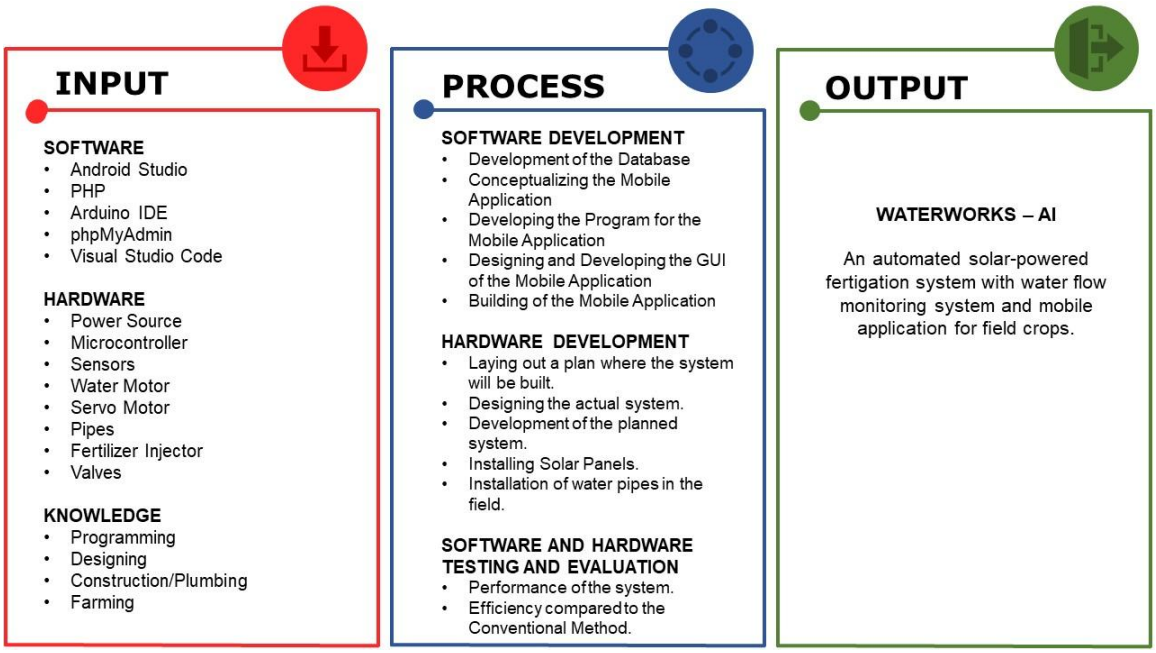


Figure 3.1 Input-Process-Output (IPO) Diagram

Figure 3.1 shows the Input-Process-Output (IPO) diagram of the study. The IPO diagram of this study aims to give an idea of what the study shall be all about. This study requires both software and hardware components to develop the system. The proponents of this study need fundamental knowledge in several

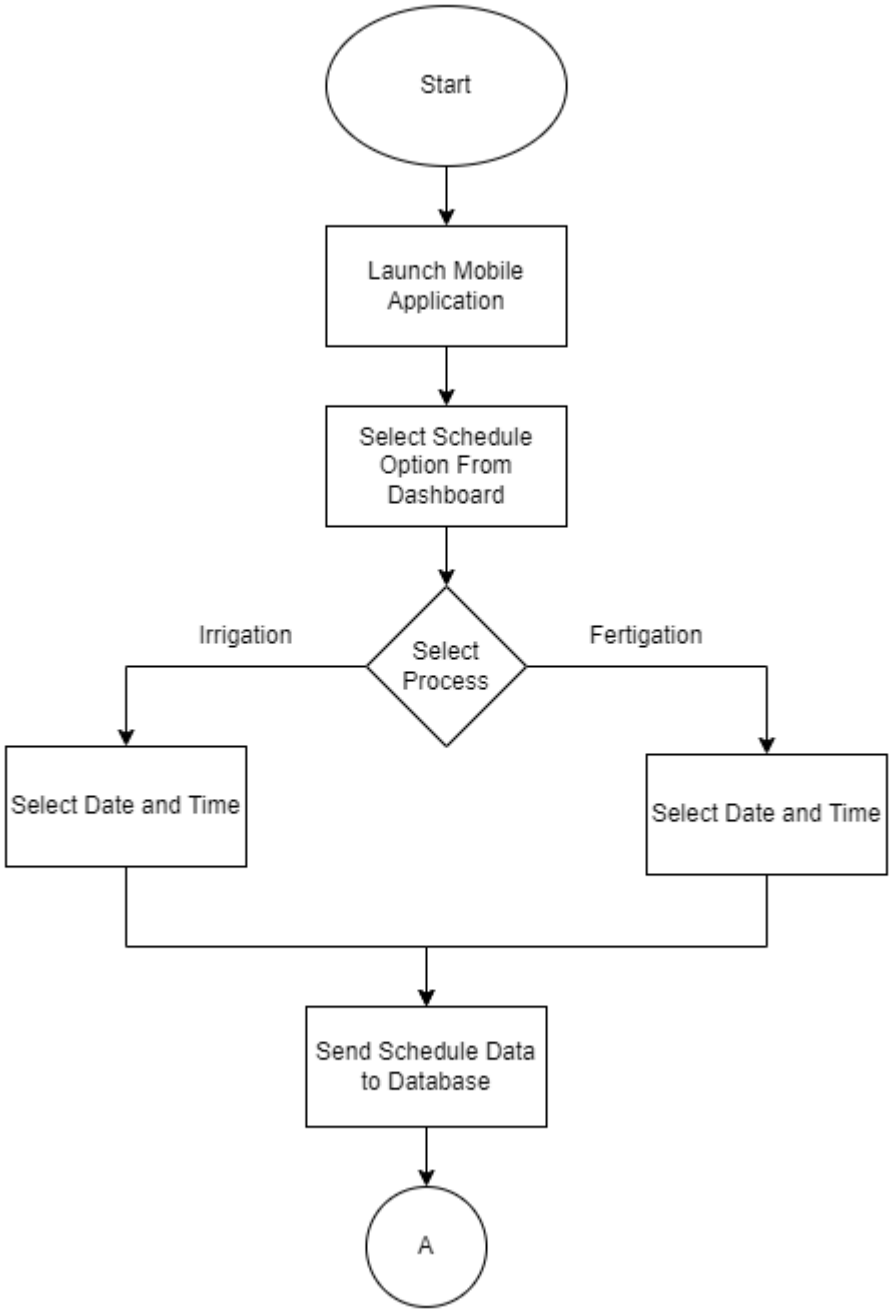
programming software or languages that help in developing the database as well as a mobile application for this study. The proponents also need some knowledge and skills in hardware that can aid in realizing the construction of the system. Also, one important knowledge to have for this fertigation system is the knowledge of farming. Since the research deals with crops and how to integrate this technology in ensuring high-quality crop products, it is necessary for the proponents to have knowledge of farming, especially on how much fertilizer a specific crop can take to avoid unfortunate happenings to occur. The process of this study was solely for designing, building, developing, and testing the system until it reaches its fully functional and efficient system for automated fertigation by utilizing solar energy as its output.

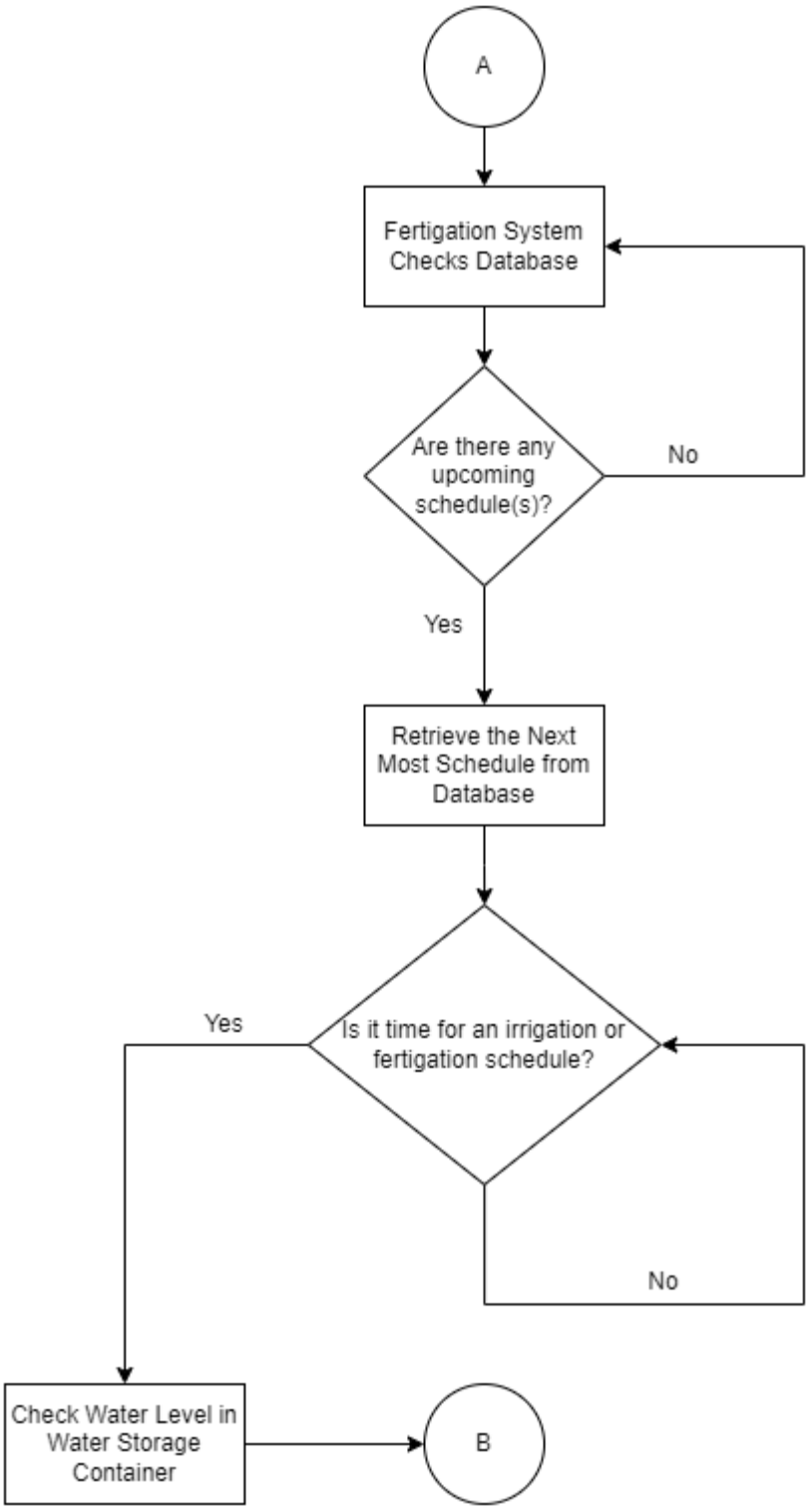
3.1.2 Research Design

The study about automated solar-powered fertigation systems adopts two research designs. The study was first be inferred as a developmental research design because it aims to develop a system that irrigates and distributes fertilizers to crops at the same time and uses solar energy as the main source of power. The researchers have conceptualized, designed, built, and developed a system that has the purpose of lessening the wasted water and the negative effects of inefficient use of fertilizers used in the manual method. The study was referred to as experimental research as it tested the functionality of the system and compare it to the conventional method used by many. The researchers conducted an

experiment on the efficiency of using an automated fertigation system compared to the manual method known by many.

3.1.3 System Flowchart




A
Fertigation System Checks Database
Are there any upcoming schedule(s)?
No
Yes
Retrieve the Next Most Schedule from Database
Is it time for an irrigation or fertigation schedule?
Yes
No
Check Water Level in Water Storage Container
B

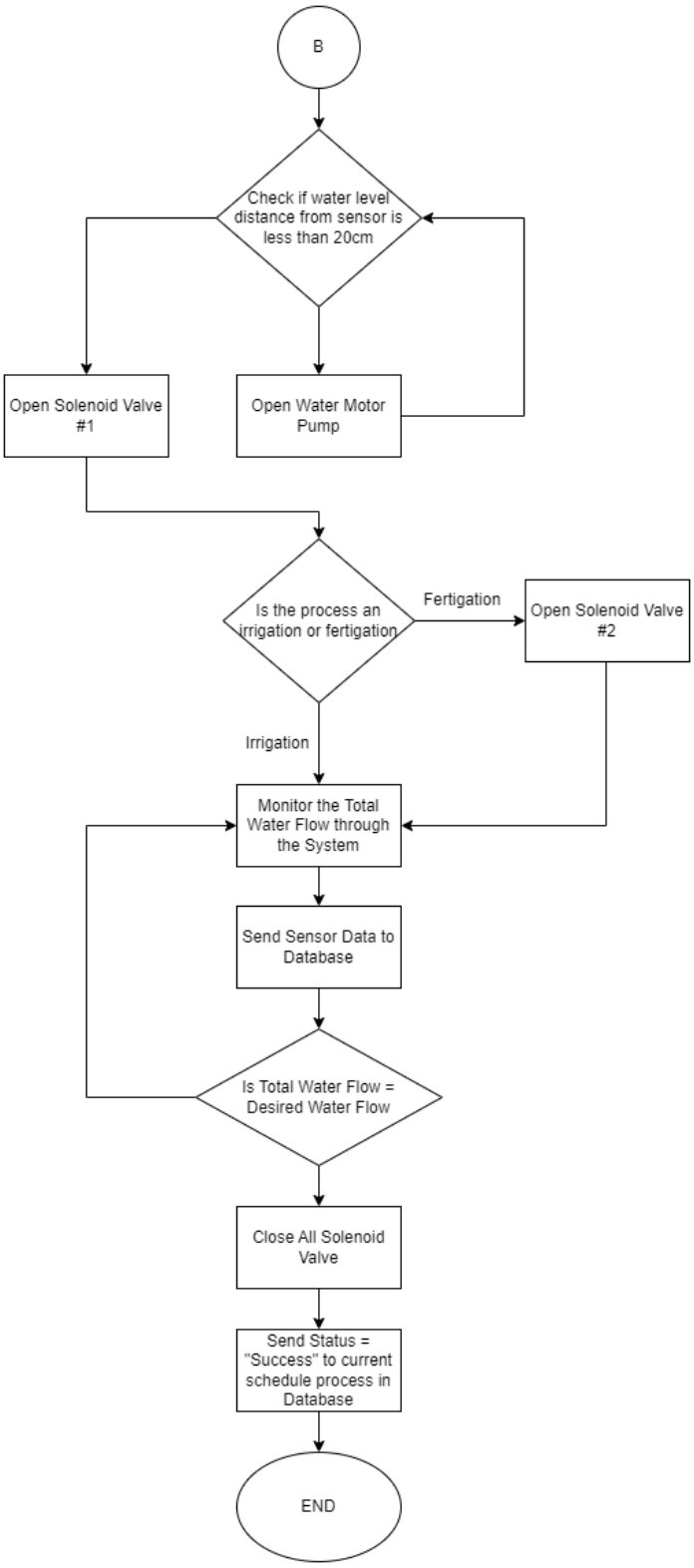
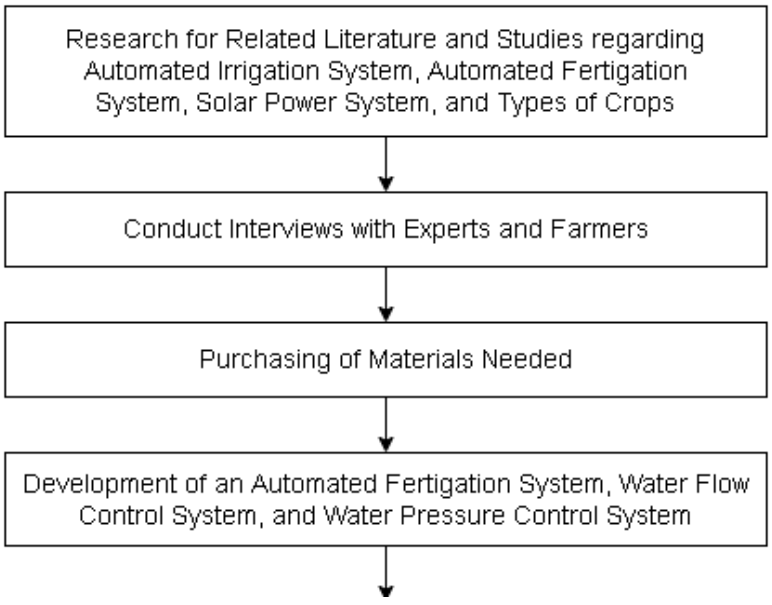


Figure 3.2 System Flowchart

The flow of the system as shown in Figure 3.2 starts from launching the mobile application wherein it requires the user to provide user identification and authentication by entering a registered user account credential in the text fields. Next is the selection of schedule from the dashboard page of the application which serves as a navigation menu that consists of multiple CardView widgets of the different features of the application. The schedule option from the dashboard showed the scheduling selection page which let users choose from two options for which process to proceed with which can either be Irrigation or Fertigation. Once the schedule is set, the irrigation or fertigation system checked the database and end user shall later be able to access the monitoring page that functions as a visual indicator for the values of the different sensors from the system until the set schedule ends.

3.2 Research Process Flow

The following figure shows the research process flow of the study.



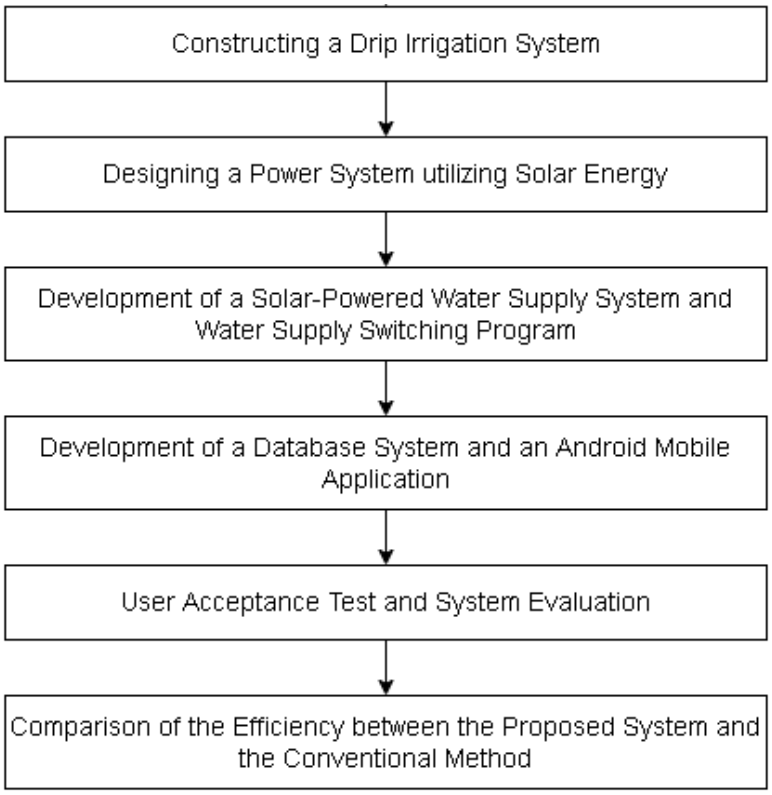


Figure 3.3 Research Process Flow Chart

This study started from the gathering and collection of previous related studies regarding automated irrigation and fertigation system and how the following literature differed from this study. It is also needed for the potential end users especially farmers and experts to be interviewed and interrogate them regarding their needs, knowledge, and expectation for this upgraded system. Followed by the purchasing of materials and equipment needed, this step is the principal necessity for us to be able to develop the actual fertigation system along with the drip irrigation, power control, water flow control, water pressure control, and database systems. Lastly, user acceptance test and system evaluation

was needed to efficiently differentiate, compare, and improve the proposed system from the conventional method.

3.3 Development of a Solar-Powered Automated Fertigation System

3.3.1 Materials and Equipment

3.3.1.1 Solar Panel

Solar panels (also termed as "PV panels") are used to convert the sunlight, which is made up of energy particles known as "photons," into electrical energy that may be utilized to power electrical loads,

The system uses two (2) 100 watts solar panels with dimensions of 1215 x 42 x 550 millimeters.

Figure 3.4 Solar Panels

3.3.1.2 Battery

Solar batteries are devices that store the energy generated by solar panels. These are also known as solar batteries. Solar batteries are used to store the electrical energy generated by photovoltaic solar panels while they are still receiving sunlight. Using it helps in gaining power even in cloudy seasons or even at night [27].

Figure 3.5 Solar Battery

The system uses Rocket: Sealed MF Rechargeable Battery with a capacity of 12V – 150Ah. It has dimensions of 485 x 170 x 240 millimeters (length x width x height).

3.3.1.3 Step-Down Converter

A step-down converter or step-down switching regulator (also known as a buck converter) is an electronic device that converts or outputs a DC output voltage that is even lower than the input voltage of the system [28].

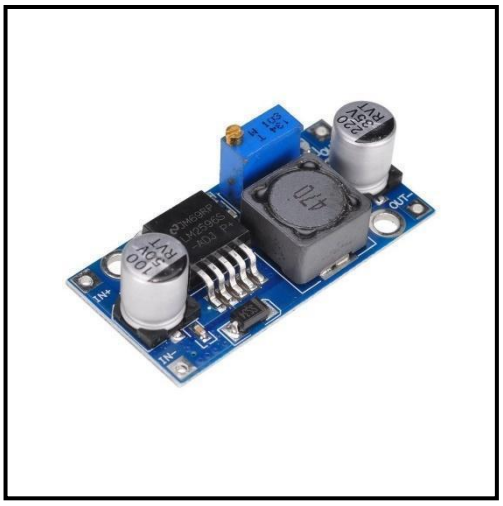


Figure 3.6 LM 2596 – 3A DC-DC Step Down (Buck) Converter Module

3.3.1.4 Solenoid Valve

A solenoid valve is a device used when liquids are to be controlled automatically [29].

Figure 3.7 Solenoid Valve

The system uses two (2) 12V Solenoid valves. One is placed after the water container to let the water flow automatically to the assembly, and

the other valve is placed in the assembly to let the water flow automatically to the Venturi Fertilizer Injector. See Figure 3.23 for reference.

3.3.1.5 Stepper Motor

A stepper motor is an electric motor whose main feature is that its shaft rotates by performing steps, that is, by moving by a fixed number of degrees. [30].

NEMA 23 – 19kgm is used in the system. This model allows the water or the water with fertilizer to flow to the pipes of the system with a diameter of 1 inch.

Figure 3.8 Stepper Motor

3.3.1.6 Valves

A valve is a type of fitting that allows for regulation, control, and direction of fluids passing through a pipe. Valves are commonly used to direct flow, shut off water access, prevent backflow, and adjust water

pressure within a system. Valves allow homeowners to isolate sections of plumbing for repairs or shut off a water line when a leak sprouts. [31].

Figure 3.9 Globe Valve (Left) and Ball Valve (Right)

3.3.1.7 Water Pressure Sensor

A pressure transducer, also known as a water pressure sensor, is a device that generates an electrical signal proportionate to the pressure it measures. It generally has a physical diaphragm made of silicon that would be flexible while being under pressure [32].

Two (2) DFRobot Gravity: Analog Water Pressure Sensor is utilized in the system. The system uses two pressure sensors to get the differential pressure value of the water entering and leaving the assembly since pressure is what the injector needs to be able to perform its tasks.

Figure 3.10 Water Pressure Sensor

3.3.1.8 Water Flow Sensor

The water flow sensor is a device that is put at the water source or in pipelines to detect the rate of flowing water and determine the volume of the water that has passed through the pipe. The water flow sensor measures the rate of flow of water in liters per hour or cubic meters per meter [33].

A magnetic core, revolving impeller, external shell and sensor, and a hall-effect sensor comprise a water flow sensor. When water flows through the rotor, the rotor rotates, activating the magnetic core to trigger switch action. The speed of the switch action varies with the rate of flow. The hall-effect sensor generates the necessary pulse signals, and by detecting the pulse, users may determine the flow speed. It can detect flow in a water dispenser or a coffee machine. There are numerous additional water flow sensors available in various sizes.

The system uses FS400A G1 Water Flow Sensor with a flow rate range of 1 – 60 liters per minute. It has a working pressure of <1.2Mpa. The sensor is used by the system as the indicator of when to stop the process when a certain flow rate is achieved in the process.

Figure 3.11 Water Flow Sensor

3.4.1.9 PVC Pipes

PVC pipes are one of the most universal and versatile forms of plastic piping, having been used for over eight decades for a wide range of purposes. PVC pipes are particularly robust and durable when compared to metal piping, with total resistance to corrosion and a low chance of suffering to heating expansion or contraction. [34].

The system used pipes with ¾ inch and 1-inch dimensions. The system also includes other pipe connectors such as pipe adapters, reducers, and pipe elbows.

Figure 3.12 PVC Pipes

3.3.1.10 Venturi Fertilizer Injector

A venturi fertilizer injector is a tool that is used to incorporate fertilizer into an irrigation system. This has no moving parts and hence does not require electricity to function. It solely uses the irrigation system's water flow to create suction, which pulls liquid fertilizers further into the irrigation system [35].

Figure 3.13 Venturi Fertilizer Injector

3.3.1.11 HDPE Tubes

HDPE pipe is a type of flexible pipe that is widely used to replace old concrete or steel mains pipes. The tubes' excellent molecular bonding and low permeability concentration make them suitable for high-pressure pipes. It is constructed of thermoplastic HDPE (high-density polyethylene) [36].

Figure 3.14 HDPE Tubes

3.3.1.12 Emitters

In an irrigation or fertigation system, emitters, or drippers, are the device which is at the end of the system that delivers the water or the water with fertilizer to the plants in a specific manner [37].

Figure 3.15 Drippers

3.3.1.13 Microcontroller

A microcontroller, also known as an MCU or a Microcontroller Unit, is a single integrated circuit (IC) used for a given application and intended to do certain functions [38].

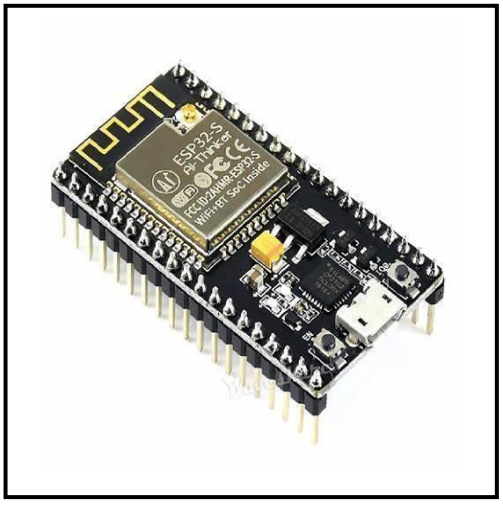


Figure 3.16 ESP32 Microcontroller

The system uses an ESP32 as it is the most advanced integrated circuit in the industry at present. It has its own wireless fidelity or Wi-Fi

module, a built-in microcontroller with antennae, and is less expensive compared to other similar products. Hence this device is very helpful in transmitting data, statistics, logs, and other informative parameters between several devices that aim to enhance system performance [39].

3.3.1.14 Relay Module

A power relay module is an electromagnetically driven electrical switch. A separate low-power signal from a microcontroller activates the electromagnet. The electromagnet draws to open or close an electrical connection when energized [40].

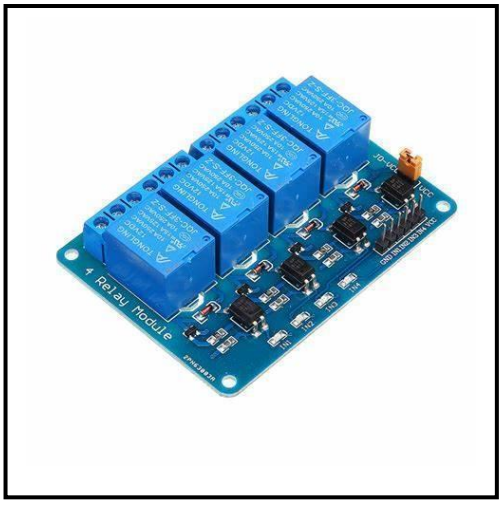


Figure 3.17 Relay Module

3.3.1.15 Switches

A Single Pole Single Throw (SPST) switch has a single input and can only connect to one output. This indicates that it only has a single input and one output terminal [41].

The model of the SPST switch that the system used is KCD1-2-101NR. The switch is a three (3) terminal switch and is red in color. This SPST switch is mainly used for turning on and off the system manually.

Figure 3.18 SPST Switch

3.3.2 Designing and Constructing the System Prototype

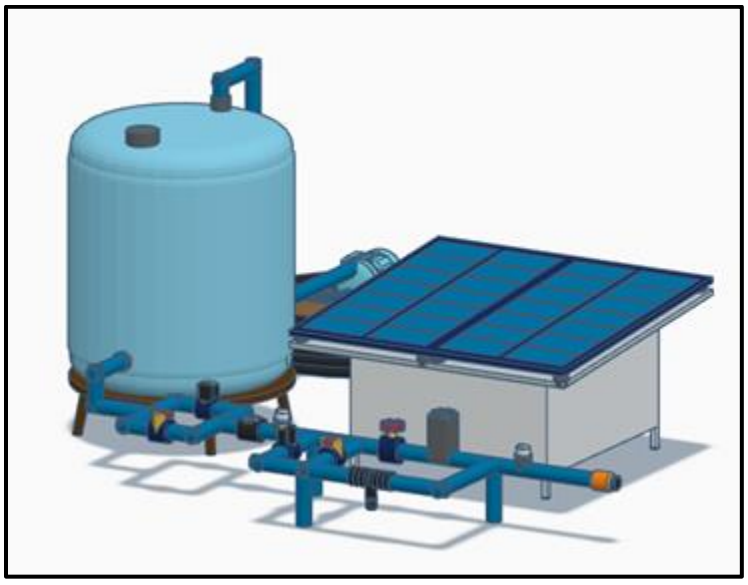


Figure 3.19 Full System Setup.

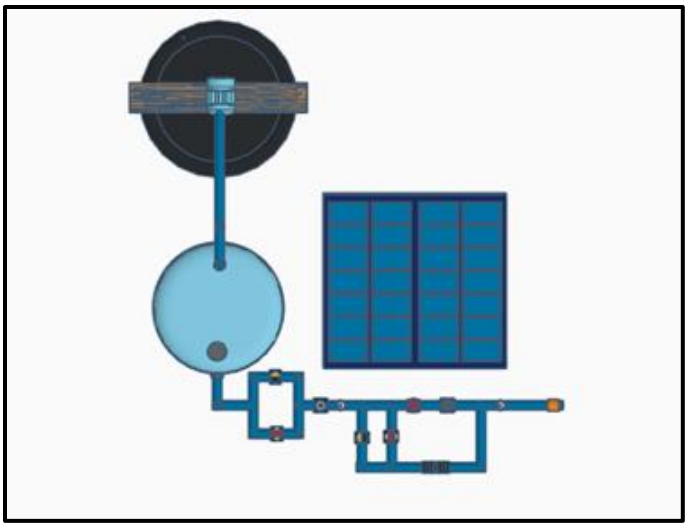


Figure 3.20 System Top-view

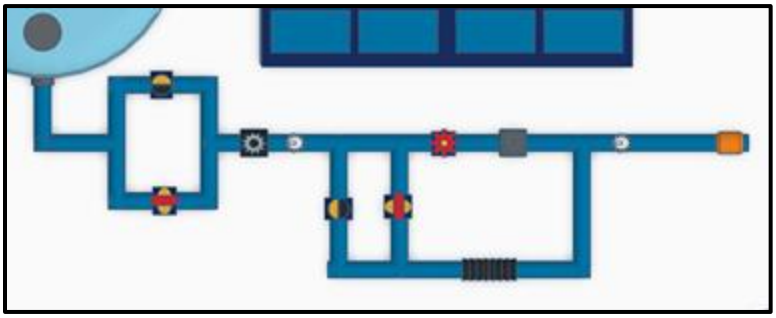


Figure 3.21 Bypass Assembly Design

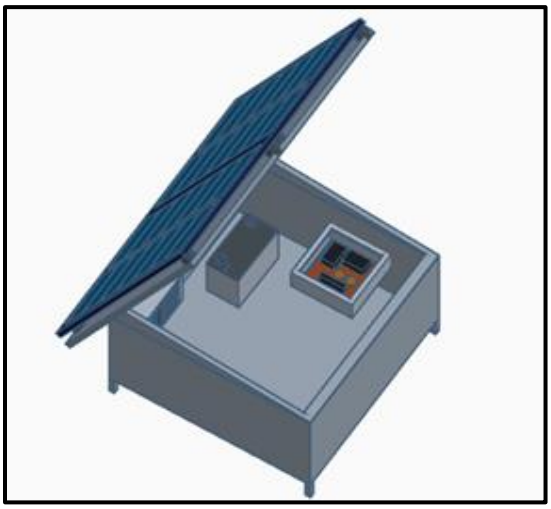


Figure 3.22 System Housing Design

A system housing is constructed to house the different components of the solar-powered automated fertigation system. The solar panels are placed on top of the housing and are connected to the control panel of the system wherein it is utilized as the power source of the overall system. The main water pipeline is connected from the water source system to the automated fertigation system and then finally to the drip irrigation system.

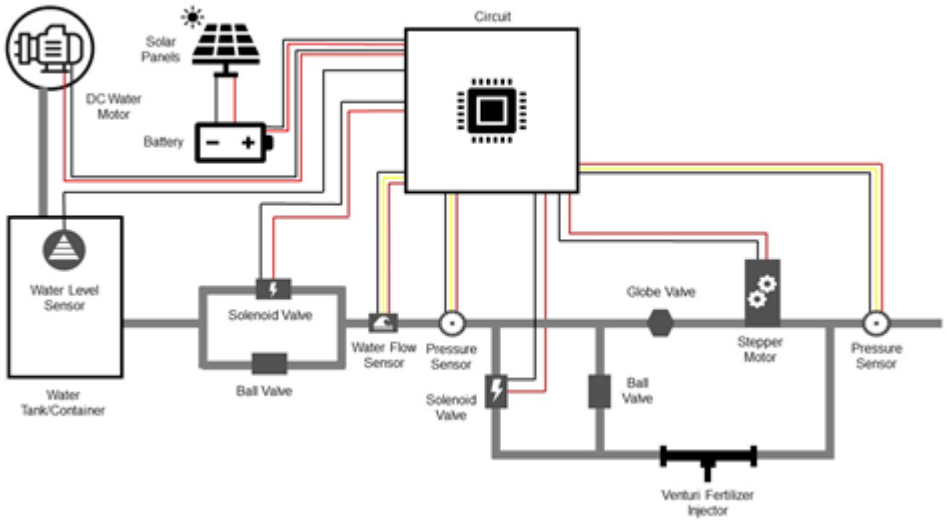


Figure 3.23 Automated Fertigation System.

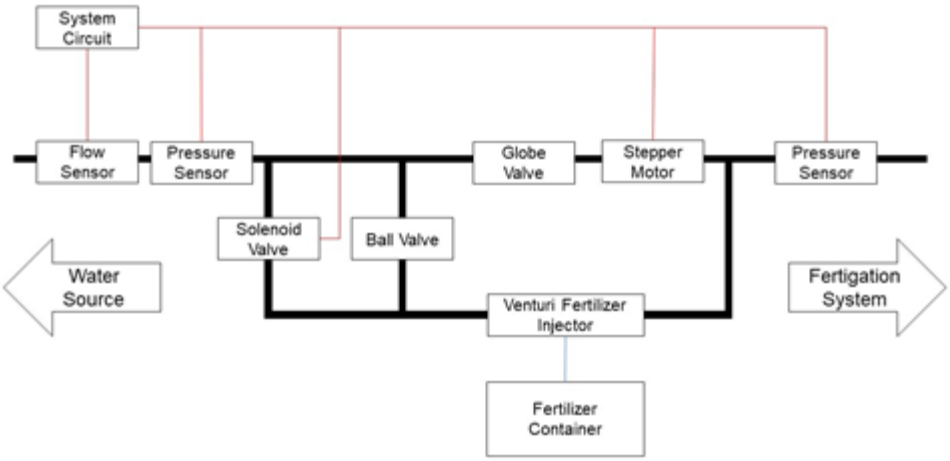


Figure 3.24 Bypass Assembly Block Diagram

The setup for the automated fertigation system includes the use of water pipes for water flow that is connected to the water source system and a bypass assembly water pipeline for the operation of the venturi fertilizer injector. Two water pressure sensors and a water flow sensor were used for monitoring the water flow rate of the system and the differential pressure of the water pipes from the water source and the irrigation system. A stepper-controlled globe valve and solenoid valves are used for controlling the fertigation process of the system by opening the bypass assembly water pipeline which redirects the water flow to the water pipeline with the venturi fertilizer injector that siphoned the fertilizer from the container and combine it with the water flow. The sensors and valves are connected to the control panel of the system. A manually operated globe valve was placed in the input of the automated fertigation system that was normally open while the system is operating automatically to allow water flow while it can be turned on and off when operating the system manually.

Manual controls are also included in the design in times of system failures. To manually open the irrigation operation, a ball valve is placed parallel to the first solenoid valve near the water container. This valve manually lets the water flow in the system when the solenoid valve is not working or not getting any power to open. A second ball valve is also placed parallel to the second solenoid valve. This ball valve can be manually opened to make the fertigation process possible when the automation of the process is not working.

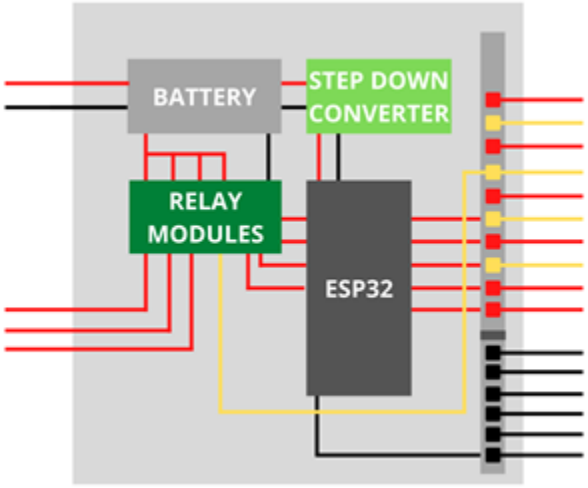


Figure 3.25 Control Panel Setup.

The control panel houses the different circuits and connections used by the system. It includes the ESP32 microcontroller, which is the main processor of the system, and the battery that is connected to both the relay modules and step-down converter for powering the different components of the system including the ESP32. Different GPIO pins of the ESP32 microcontroller are utilized for controlling the relay modules and for collecting the data gathered from the sensors.

3.3.3 Constructing the Irrigation System

Figure 3.26 Drip Irrigation.

Drip irrigation is a type of micro-irrigation method that reduces water waste while also ensuring that water reaches the plant's roots. It acts by gently dripping the water to the ground. Drip irrigation can be applied from both above and below the soil's surface. It ensures that all the crops or plants receive the water they need. Though the drip irrigation method is slow, it ensures that the user's work is done appropriately. It directs water directly into the plant roots while simultaneously reducing evaporation. Some networks are used to deliver water evenly throughout all the plants. These components include valves, pipes, tubing, and emitter [42].

3.3.4 Programming of the Water Flow and Water Pressure Control System

3.3.4.1 Water Flow Control System for Irrigation Process

The flow control system used the data from the water flow sensor linked to the water pipeline from the water source system in Figure 3.23 to regulate the irrigation operation. This system regulates the amount of water

distributed by the system. The program utilized a value for the intended flow rate as input and compare it to the value measured by the water flow sensor. The water flow sensor's value was initially set to 0. If the observed flow rate is lower than the target flow rate, the system continued to supply additional water to the irrigation system.

```
void Flow() {

  currentMillis = millis();
  if (currentMillis - previousMillis > interval) {

    pulse1Sec = pulseCount;
    pulseCount = 0;

    flowRate = ((1000.0 / (millis() - previousMillis)) * pulse1Sec) / calibrationFactor;
    previousMillis = millis();

    flowMilliLitres = (flowRate / 60) * 1000;
    flowLitres = (flowRate / 60);

    totalMilliLitres += flowMilliLitres;
    totalLitres += flowLitres;

    // Print the flow rate for this second in litres / minute
    Serial.print("Flow rate: ");
    Serial.print(int(flowRate));  // Print the integer part of the variable
    Serial.print("L/min");
    Serial.print("\t");       // Print tab space

    // Print the cumulative total of litres flowed since starting
    Serial.print("Output Liquid Quantity: ");
    Serial.print(totalMilliLitres);
    Serial.print("mL");
    Serial.print("\t");       // Print tab space
    Serial.print(totalMilliLitres/1000);
    Serial.println("L");

    Pressure();
  }
}
```

Figure 3.27 Flow Sensor Arduino Program

3.3.4.2 Water Pressure Control System for Fertigation Process

The two water pressure sensors are used for calculating the differential pressure between the inlet and outlet of the venturi fertilizer injector. The fertigation process of the system utilizes the venturi effect which siphons the liquid solution from the fertilizer container up to the injector by creating a vacuum inside the injector when a certain percentage of differential pressure is applied to the injector.

The inlet must have a higher pressure than the outlet by 20% to 50% differential pressure. A stepper-control valve is utilized for controlling the water flow and pressure in the main water pipeline and the bypass assembly pipeline which creates a closed-loop system that controls the flow and differential pressure between the inlet and outlet of the injector by utilizing the data collected from the water pressure sensors.

```
void Pressure() {

  V1 = analogRead(WPSense1) * 5.00 / 4096;     //Sensor1 output voltage
  delay(100);
  V2 = analogRead(WPSense2) * 5.00 / 4096;     //Sensor2 output voltage
  delay(100);
  //Calculate water pressure
  P1 = (V1 - OffSet) * 250;
  P2 = (V2 - OffSet) * 250;

  Serial.print("Voltage1:");
  Serial.print(V1, 3);
  Serial.println("V");

  Serial.print(" Pressure1:");
  Serial.print(P1, 1);
  Serial.println(" KPa");
  Serial.println();

  Serial.print("Voltage2:");
  Serial.print(V2, 3);
  Serial.println("V");

  Serial.print(" Pressure2:");
  Serial.print(P2, 1);
  Serial.println(" KPa");
  Serial.println();

  PDIFF = abs(((P2 - P1)/(P1) * 100));
}
```

Figure 3.28 Pressure Sensor Arduino Code

3.3.5 Design Consideration for the Power Management System

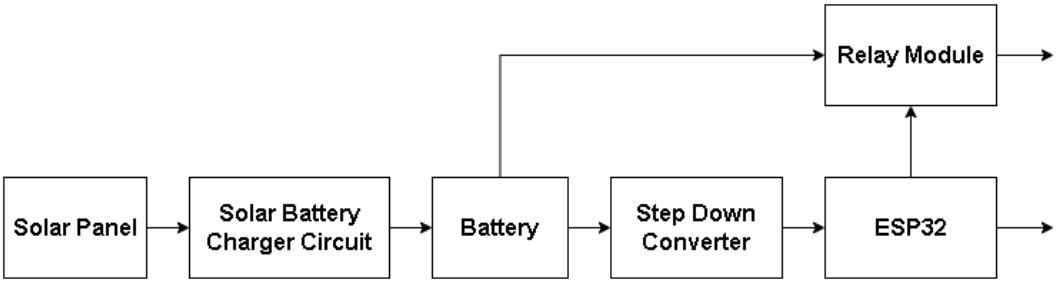


Figure 3.29 Block Diagram of Solar Power System

Figure 3.29 describes the block diagram for the automated fertigation system's power supply, which powers all the system's components. The system's primary source of energy is batteries, which are recharged using solar panels and a charger developed particularly for solar batteries. This setup enables effective solar power capture and storage. The system's integrated battery oversees supplying power to critical electrical components such as the microcontroller, sensors, solenoid valves, water pump, and other critical parts.

The power consumption of each component and equipment in the automated fertigation system is as shown below.

Table 3.1. Power Consumption in the Automated Fertigation System

Item	Quantity	Power per Quantity	Total Power
LSWQB 12V Water Motor Pump	1	180W	180W
1” DC 12V Brass Solenoid Valve	1	24W	24W
1” DC 24V Brass Solenoid Valve	1	24W	24W
Wemos D1 R32 ESP32 Microcontroller (Maximum Power Consumption)	1	0.792W	0.792W
TB6600 Stepper Motor Driver	1	30W	30W
HW-688 Buck Converter	1	13.333W	13.333W

LM2596S Buck Converter	1	7W	7W
4-Channel 5V Relay Module	1	800mW	800mW
2-Channel 5V Relay Module	1	400mW	400mW
DS3231 RTC Module	1	6.6mW	6.6mW
JSN-SR04T Ultrasonic Sensor	1	50mW	50mW
FS400A G1 Water Flow Sensor	1	75mW	75mW
DFRobot Gravity Analog Water Pressure Sensor	2	14mW	28mW
Total Power Consumption			280.49W

The total power being consumed by the system is approximately 280.49W. Compared to the capacity of the battery used which is a 12V 150Ah that is equivalent to 1800W, the total power consumed is less than the capacity of the battery assuming that the system is working for one hour. This means that the battery of the system can perform an operation multiple times in one charge.

3.3.6 Initial Testing of the Prototype

A series of tests was conducted once the solar-powered automated fertigation system is set up. These tests also included components' calibrations and testing. The said tests checked the functionality and performance of the system prototype.

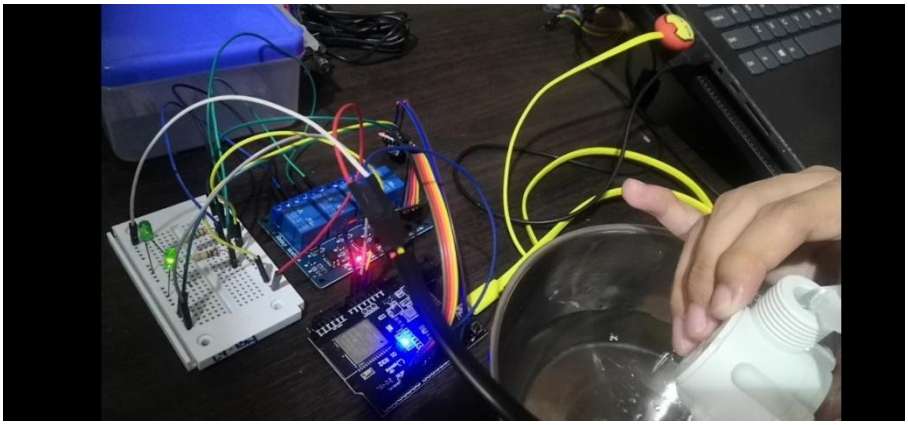


Figure 3.30 Initial Flow Sensor Calibrations

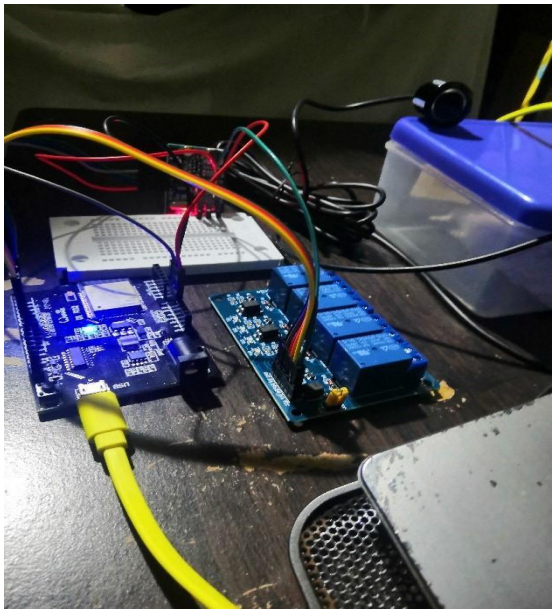


Figure 3.31 Initial Level Sensor Testing

Figure 3.32 First Field Testing of the System

3.4 Development of a Solar Powered Automated Water Supply System

3.4.1 Materials and Equipment

The power management system that implemented the ESP32 microcontroller utilized in the automated fertigation system was utilized for the solar-powered automated water supply system.

3.4.1.1 Water Motor Pump

A water pump is widely used to increase pressure, transfer, and circulate a wide range of fluids, including oil, water, acidic and alkaline substances, drinkable liquids, mixes, and others. Its uses are many and include home appliances, autos, pools, wells, pet water dispensers, and aquariums, fish tanks, decorative water fountains, water heaters, circulation of water setups, automotive temperature control systems, and similar scenarios. The system includes a 12V DC Solar Pump with a maximum flow rate of 1.5m3/H and a maximum head of 15 meters (49.21 ft.), which represents the motor's highest point. It needs 180 watts of power to operate. The diameter of the inlet and outlet of the motor is 1-inch.

Figure 3.33 Water Pump

3.4.1.2 HDPE Drums

Polyethylene drums, sometimes known as plastic drums, are industrial-grade containers composed of high-density polyethylene (HDPE). They are lower in weight and thought to become more economically efficient than steel drums [43].

The system uses one (1) Closed-head Mauser drum with a capacity of 220 liters. It has a height of 922 millimeters and a diameter of 580 millimeters.

Figure 3.34 Water Container

3.4.1.3 Ultrasonic Level Sensor

The ultrasonic level sensor measures the level of non-foaming chemical, water, wastewater, and petroleum-based liquids in the ambient tank or sump applications from 1 to 12 meters [44].

The JSN-SR04T was used in the system. The sensor is waterproof, easy to use, and has 5 volts operating voltage with 40kHz frequency. It has a cable length of 2.5 meters and can detect water levels ranging from 25 to 450 centimeters.

Figure 3.35 Ultrasonic Level Sensor

3.4.2 Constructing a Solar Power Deep Well System

A water source system focusing on a deep well utilizes a solar-powered DC water pump with a manual switch for control of the operation. Furthermore, the system has a relay module that allows the water motor to operate automatically, eliminating the need for reliance on the switch.

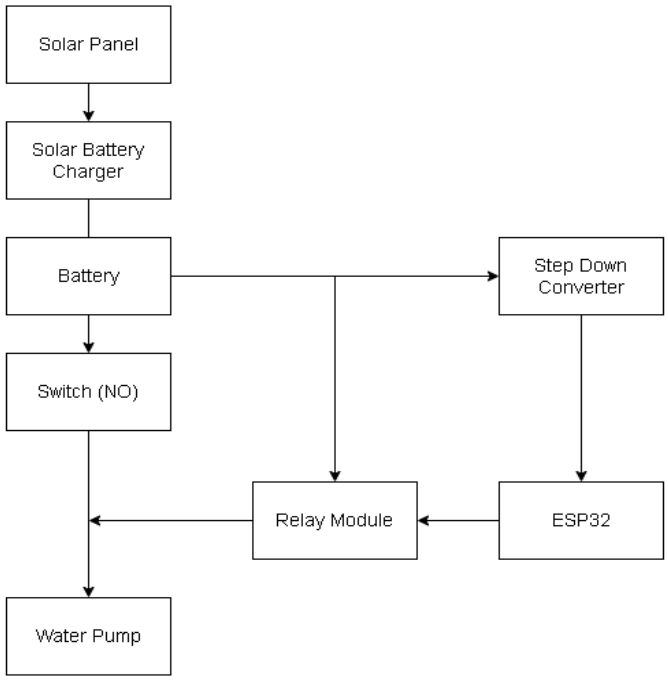


Figure 3.36 Deep Well Control Circuit Connections

3.4.3 Designing and Constructing the Automated Water Supply System

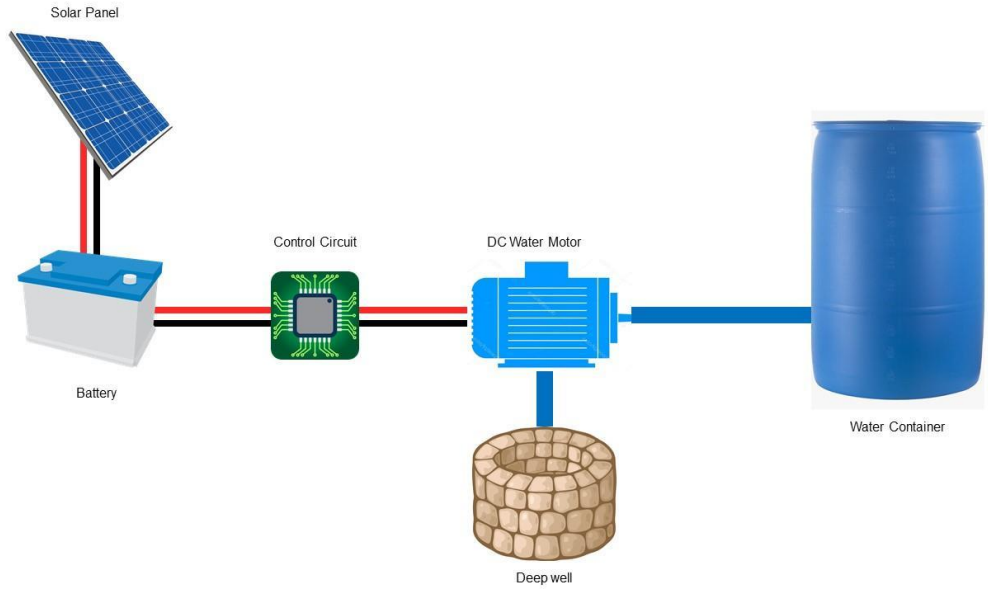
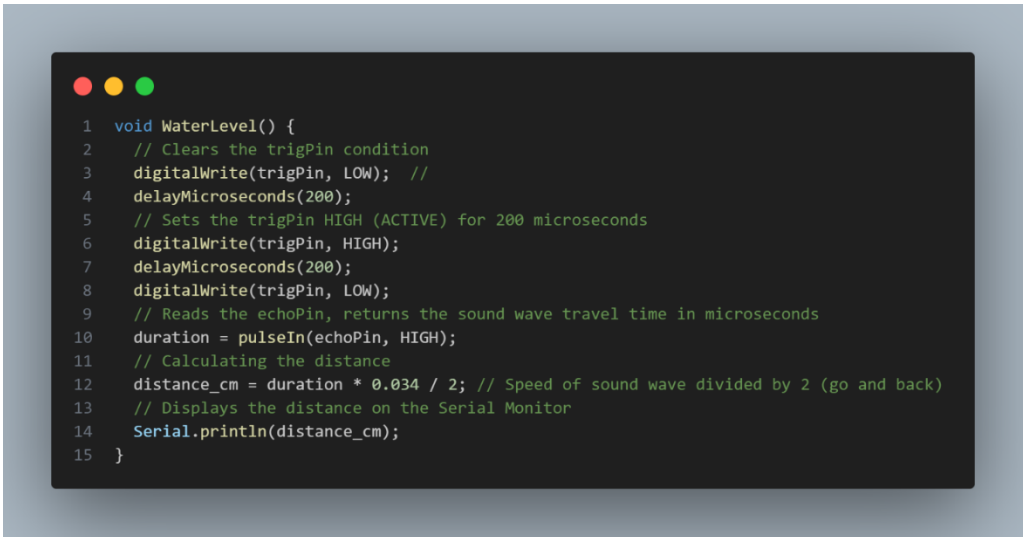


Figure 3.37 Water Supply System

The solar-powered deep well system was utilized to provide water to the water supply containers to be used by the automated fertigation system. The deep well has a depth of around 27 feet and it was the source of water that filled the container. The water level of the container was monitored using an ultrasonic level sensor.

3.4.4 Software Development of the Automated Water Supply System

A program that is developed allowed the system to monitor the water level of the water container by utilizing the data from the JSN-SR04T ultrasonic sensors for the automated fertigation system. The level of the water inside the container determines the action of the system. In a scheduled process, once the water level is below the accepted level stated on the program, the motor turned on first and filled the container. Once it reached the desired amount or readings the motor stopped running and proceeded to the process of irrigation and/or fertigation.



```
void WaterLevel() {
  // Clears the trigPin condition
  digitalWrite(trigPin, LOW);  //
  delayMicroseconds(200);
  // Sets the trigPin HIGH (ACTIVE) for 200 microseconds
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(200);
  digitalWrite(trigPin, LOW);
  // Reads the echoPin, returns the sound wave travel time in microseconds
  duration = pulseIn(echoPin, HIGH);
  // Calculating the distance
  distance_cm = duration * 0.034 / 2; // Speed of sound wave divided by 2 (go and back)
  // Displays the distance on the Serial Monitor
  Serial.println(distance_cm);
}
```

Figure 3.38 Water Level Sensor Arduino Code

3.4.5 Initial Testing of the Automated Water Supply System

The automated water supply system is evaluated by manually altering the numeric value linked with the water container in the controlling software responsible for switching water sources. This stage assesses the effectiveness of the container changeover operation. In addition, an examination was performed to ensure that the water level monitoring system within the water supply is working properly.

3.5 Development of an Android Mobile Application for Irrigation Scheduling and Monitoring

3.5.1 Development of a Database System

A database system was developed using a web hosting service that stored information about the irrigation schedules set by the user of the system. The development of the database used the programming languages SQL and PHP.

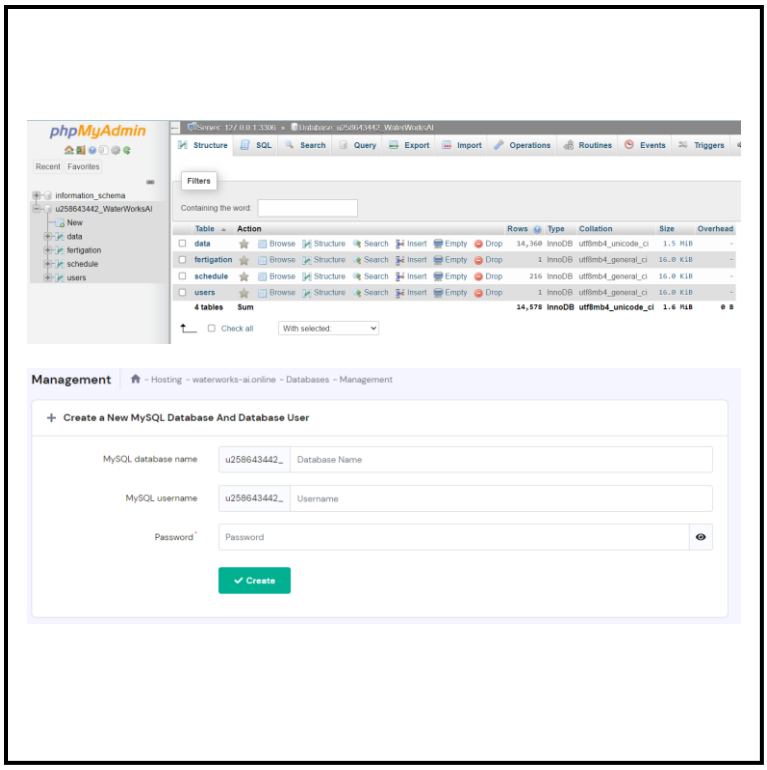


Figure 3.39 Database Creation

3.5.2 Design Considerations for the Android Mobile Application

An Android mobile application developed allowed the user to set the schedule for an irrigation process. A dashboard for irrigation was implemented to give users with regular information on the progress of ongoing irrigation procedures. Furthermore, this program monitored the system's operational state, showing whether it is currently operating or on its inactive phase.

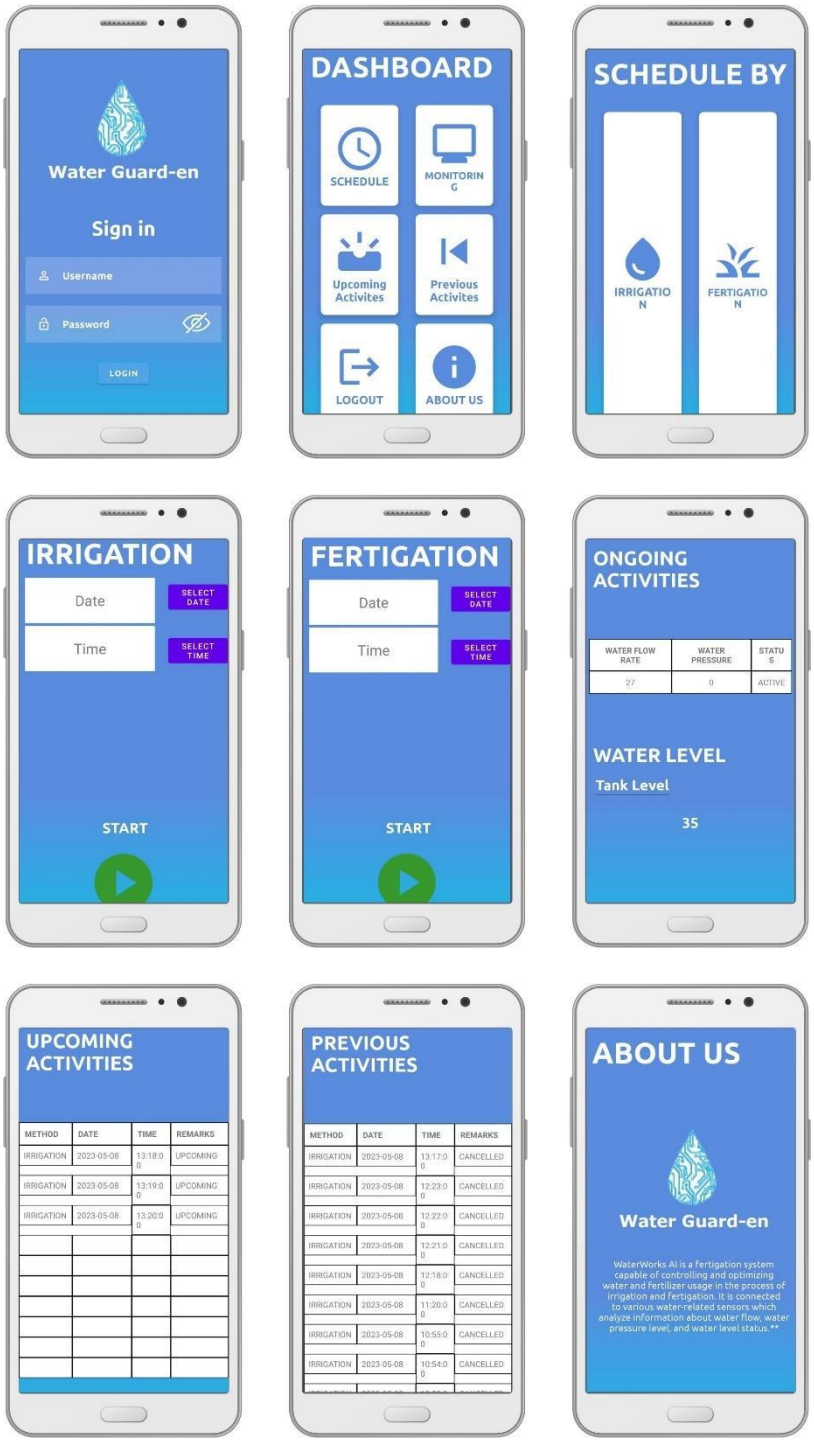


Figure 3.40 WaterWorks - AI Mobile Application User Interface

3.5.3 Programming of the Front End of the Mobile Application

The mobile application's user interface design focuses on the aesthetic features of the program rather than the precise functionality that was implemented into the application.

The system’s mobile application front end was developed using the Android Studio application.

3.5.4 Programming of the Back End of the Mobile Application

Back-end development of the mobile application includes the operation and functionality of the different features of the application. Different features to be implemented include login feature, irrigation scheduling and display of irrigation schedule, monitoring of the status of the automated fertigation system and the automated water supply system.

3.5.5 Integrating the Automated Fertigation System to the Mobile Application

The automated fertigation system was integrated to the mobile application. The data from the system was sent to the database system that allowed the mobile application to collect the data for monitoring and to connect to the automated fertigation system to input or discard an upcoming irrigation schedule.

3.5.6 Integrating the Automated Water Supply System to the Mobile Application

The automated system for water supply was smoothly integrated into the mobile application by delivering system data to the database. The program was able to provide the current water level condition of the water supply system by obtaining information from the system.

3.5.7 Initial Testing of the Software Application

An initial testing for the mobile application was conducted to determine the functionality of its features and the connectivity of the different systems.

3.6 User Acceptance and System Evaluation

This system was used on a farm where its functionality and performances were observed and compared with conventional methods in that area. The changes that took place in the crops was based on whether the use of the automated system has been more effective than the manual method. The owner or people on the plantation were also asked for their feedback that confirmed the outcome of this study.

A survey feedback or evaluation form was used to get the insights of the farmers in the area. The questionnaire is composed of questions that reflect the functionality and efficiency of the system according to the farmers. The sample questionnaire below is the one that was used by the farmers and other people that knows the system for their evaluation

WATER GUARDEN: WATERWORKS AI SURVEY FORM

Introduction: The students involved in the study need to conduct a survey for the evaluation of different aspects of the technology developed in the research entitled ***"WATERWORKS - AI: DEVELOPMENT OF A SOLAR-POWERED AUTOMATED FERTIGATION SYSTEM WITH IRRIGATION SCHEDULING AND WATER FLOW CONTROL SYSTEM FOR FIELD CROPS UTILIZING DRIP IRRIGATION WITH MOBILE APPLICATION".***

It is expected that the questionnaire will take about 15 minutes to complete. If you consent to participate, your responses will be kept confidential. The information provided will be used solely for the purpose of this research project and only aggregated results will be reported in reputable academic publications. No persons other than my supervisors and I will have access to the information you provide. Your participation is voluntary, and you are free to withdraw consent at any time and to withdraw any unprocessed data you have previously supplied. Upon completion of the research, all questionnaires will be securely stored.

(Inaasahan na ang talatanungan ay aabutin ng 15 minuto upang makumpleto. Kung pumayag kang lumahok, ang iyong mga tugon ay panatilihing kumpidensyal. Ang impormasyong ibinigay ay gagamitin lamang para sa layunin ng proyektong ito ng pananaliksik at ang mga pinagsama-samang mga resulta ay maiulat sa kagalang-galang na mga publikasyong pang-akademiko. Walang ibang tao maliban sa aking mga superbisor at magkakaroon ako ng access sa impormasyong iyong ibinibigay. Ang iyong pakikilahok ay kusang-loob, at malaya kang mag-alis ng pahintulot sa anumang oras at mag-alis ng anumang hindi pa nasuri na data na dati mong naibigay. Kapag natapos ang pananaliksik, ang lahat ng mga talatanungan ay ligtas na maiimbak.)

NAME (PANGALAN):	**AGE (EDAD):**
GENDER (KASARIAN):	**OCCUPATION (TRABAHO):**

AWARENESS AND FAMILIARITY WITH THE PROJECT

Do you have any prior experience or knowledge about similar technologies?
(Mayroon ka bang naunang karanasan o kaalaman tungkol sa mga katulad na teknolohiya?) *Answer:*

Figure 3.41 Sample Questionnaire Page 1

TECHNOLOGY EVALUATION				
	STRONGLY DISAGREE	DISAGREE	AGREE	STRONGLY AGREE
IRRIGATION/FERITGATION SYSTEM				
1. The automated fertigation system is more convenient than the conventional method. **(Ang awtomatikong sistema ng fertigasyon ay mas maginhawa kaysa sa nakasanayan na pamamaraan.)**				
2. The use of solar panels as power source is beneficial to the local farmers. **(Ang paggamit ng mga solar panel bilang mapagkukunan ng kuryente ay kapaki-pakinabang sa mga lokal na magsasaka.)**				
3. The project lessens the cost of maintenance of the irrigation system compared to the previous system used. **(Binabawasan ng proyekto ang gastos ng pagpapanatili ng sistema ng patubig kumpara sa nakaraang sistema na ginamit.)**				
4. The system outputs accurate amount of fertilizer. **(Ang sistema ay naglalabas ng tumpak na halaga ng pataba.)**				
5. The system shows many inconsistencies on it. **(Ang systema ay nagpapakita ng maraming hindi pagkakapare-pareho dito.)**				
6. The system's function increases efficiency on the farmer's job. **(Ang pagpapaandar ng sistema ay nagdaragdag ng kahusayan sa trabaho ng magsasaka.)**				
7. The system lessens the existing farmer's workload. **(Binabawasan ng sistema ang umiiral na trabaho ng magsasaka.)**				

Figure 3.42 Sample Questionnaire Page 2

8. The project helps in conserving water using drip irrigation. **(Tumutulong ang proyekto sa pag-titipid ng tubig gamit ang drip na patubig.)**				
9. The reliability of the system is satisfactory. **(Ang pagiging maaasahan ng system ay kasiya-siya.)**				
MOBILE APPLICATION				
1. The project has a user-friendly interface for the mobile application and is very easy to access and control. **(Ang proyekto ay may user-friendly interface para sa mobile application at napakadaling ma-access at kontrolin.)**				
2. The software has all the functions and capabilities I expected it to have. **(Ang software ay may lahat ng mga pag-andar at kakayahan na inaasahan kong magkaroon ito.)**				
3. I can easily add and/or delete irrigation or fertigation schedules. **(Madali akong magdagdag at / o magtanggal ng mga iskedyul ng patubig.)**				
4. The gathered data of the system are very helpful. **(Ang natipon na data ng system ay lubos na kapaki-pakinabang.)**				
OVERALL FEEDBACK				
1. This project is useful to the overall work of the local farmers. **(Ang proyektong ito ay kapaki-pakinabang sa pangkalahatang gawain ng mga lokal na magsasaka.)**				
2. This project gives me satisfaction by its performance. **(Ang proyektong ito ay nagbibigay sa akin ng kasiyahan sa pamamagitan ng pagganap nito.)**				
3. I feel comfortable using this system. **(Kumportable ako sa paggamit ng sistemang ito.**				

Figure 3.43 Sample Questionnaire Page 3

3. The project can be used for a long period of time in mind. **(Ang proyekto ay maaaring magamit para sa isang mahabang panahon.)**				
4. Through this project, it lets me widen my technological perspective. **(Sa pamamagitan ng proyektong ito, hinahayaan akong palawakin ang aking pananaw sa teknolohiya. 0**				
5. I will recommend this project to other local farmers I know and work with. **(Inirerekumenda ko ang proyektong ito sa ibang mga lokal na magsasaka na kilala ko at nakikipagtulungan.)**				
6. The project fits perfectly with the needs of the farm. **(Ang proyekto ay umaangkop nang perpekto sa mga pangangailangan ng bukid.)**				

BENEFITS AND IMPACT
What are the possible benefits and impacts of this project in your field of work? **(Ano ang mga posibleng benepisyo at epekto ng proyektong ito sa iyong larangan ng trabaho?)** *Answer:*

Figure 3.44 Sample Questionnaire Page 4

SUGGESTION AND IMPROVEMENTS
Do you have any specific features or functionalities you would like to see added or modified? **(Mayroon ka bang anumang mga tukoy na tampok o pag-andar na nais mong makita ang idinagdag o binago?)** *Answer:*
USAGE AND ADOPTION
How likely is it for you to do a transition and use/adopt the project? **(Gaano kadalas para sa iyo na gumawa ng isang paglipat at gamitin / itangkilik ang proyekto?)** *Answer:*

Thank you for taking the time to complete this survey questionnaire. We greatly value your cooperation, and we are deeply grateful for your time and consideration.

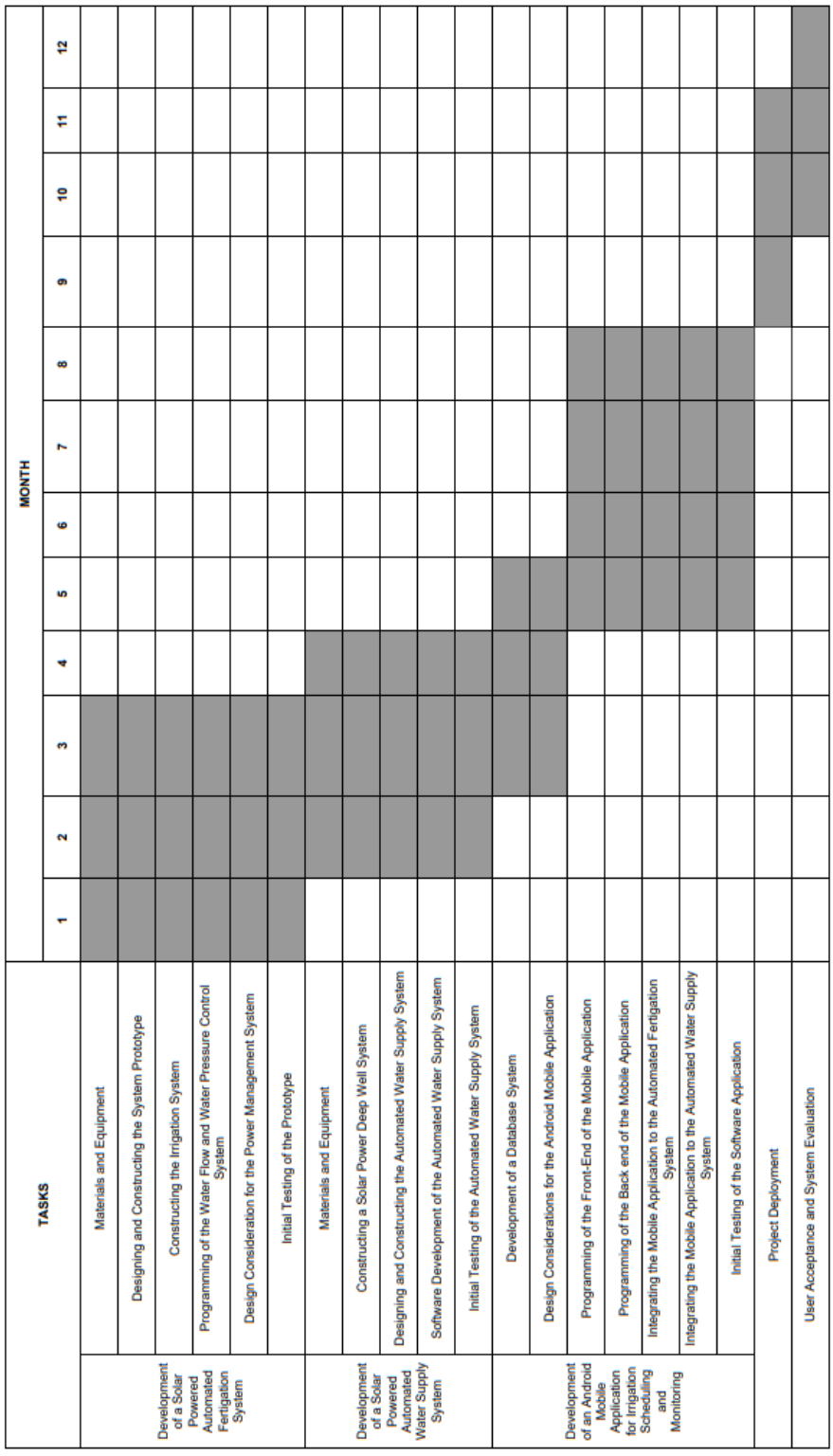
If you have any questions or want to be kept updated regarding this project and/or willing to participate in future research, feel free to contact us on 09303014212 or 09163207552 (Jireh Dawn Cruz) or send an email to jirehdawn.cruz@tup.edu.ph or cruz.jirehdawn@gmail.com.

Figure 3.45 Sample Questionnaire Page 5

3.7 Statistical Analysis

This study about automated solar-powered fertigation systems used measures of central tendency such as mean, median, and mode to describe the data provided by the user or feedback obtained from the user. Since this project also aims to conduct user acceptance testing to determine the efficiency of the system, the proponents used a 4-point Likert scale to successfully determine their opinions on the accomplished project. The study also used the T-test as its statistical analysis. Since this study in addition to being developmental research was also designed as experimental research, it aimed to compare the efficiency of the automated fertigation system compared to the conventional method where the application of fertilizer to the soil is done separately with watering the crops. The last statistical method for evaluating gaps between different means which may or may not be associated is the T-test. The samples for the testing are collected randomly from the two groups or categories. It is a statistical procedure in which samples are picked at random and no perfect normal distribution exists [45]. The data or the measurements were collected at a certain time upon finishing installing the system on the farm. Specifically, the T-Test analysis to be used is the Independent Two-Sample T-Test. This test is conducted when samples from two different groups, species, or populations are studied and compared. It is also known as an independent T-test.

3.8 Project Work Plan



CHAPTER 4

DATA AND RESULTS

This chapter presents the different gathered data and the analysis of the results for the system that is related to the tests conducted and the evaluation done to assess the system.

4.1 System Initial Testing Setup

The capacity of the system to gather and utilize sensor data to automate the whole flow of the irrigation and fertigation system was the first system component to be examined.

Figure 4.1 Full System Setup

Figure 4.2 Actual Fertigation Assembly

The tests were conducted for numerous days owing to technology limitations, a small number of component malfunctions, and inconsistent data collected. The irrigation system was simulated at the same time the crops were just planted. There are several parameters that were observed such as the water level, pressure rate, and water flow as these served as the data priority for this project. During the first test, the water pump was turned on to demonstrate the requirements of this system to crops and for the whole fertigation system to perform and collect initial statistics.

Figure 4.3 Developed Mobile Application

The mobile app presented offers several possibilities and functionalities that improve the fertigation application and the user experience. Moreover, using the proposed application gives end users a mechanism to make them aware of the advantages of installing modern fertigation control systems for different field crops. Such a variety of options allows users to try out different processes and compare the results obtained. The mobile application was able to display valuable information by means of a results report. The user can input various parameters such as manual input of irrigation and fertigation schedules, monitoring of the gathered data for water level, pressure rate, and water flow, and more.

4.2 Performance Analysis of the Automated Fertigation System

This part contains a comprehensive performance analysis of the automated fertigation system, evaluating its efficiency and efficacy in terms of water usage and nutrient delivery. The performance of the system is crucial in determining its ability to

improve irrigation systems and increase agricultural productivity. Proponents meticulously gather and analyze data to assess essential qualities such as water-related sensors, nutrient supply precision, system reliability, and energy efficiency. This analysis provides critical insights into the operational performance of the automated fertigation system, allowing us to analyze its applicability and impact on sustainable agriculture practices.

The system used three water-related sensors which were instrumental in obtaining and analyzing the data for this automated fertigation system. The sensors identified in this research are the water level sensor, water flow rate sensor, and the water pressure sensor. The result of each were further expanded in the next sections.

4.2.1. Water Level Sensor

The water level sensor is an important part of the automated fertigation system since it allows for monitoring and control of water usage. The proponents focus in this part on examining the ability of the water level sensor in accurately measuring water levels in the used water container. Proponents acquire significant insights regarding the system's potential to optimize water use and assure efficient irrigation methods by assessing its reliability, sensitivity, and responsiveness. In this study, researchers offer new findings that add to an improved comprehension of the way the water level sensor improves system efficiency and its consequences for resource management in agricultural settings.

Water level data is essential to this study as it enables the system to activate the irrigation or fertigation process once a certain level is reached. It also shows the

corresponding amount of time it takes to fill the water storage container of the automated water source system.

The water level data presented is a representative sample from the five most recent processes done in the system.

Table 4.1 Time interval of Water Level to reach certain percentages.

Percentage	2023-05-16 16:52:00	2023-05-17 11:16:00	2023-05-30 17:00:00	2023-05-31 09:37:00	2023-05-31 12:02:00
0%	----------	----------	----------	----------	----------
20%	6 min 6 sec	5 min 28 sec	4 min 40 sec	7 min 18 sec	6 min 48 sec
40%	11 min 18 sec	10 min 56 sec	8 min 24 sec	15 min 44 sec	19 min 36 sec
60%	15 min 36 sec	16 min 24 sec	11 min 16 sec	24 min 24 sec	33 min 12 sec
80%	21 min 12 sec	21 min 52 sec	14 min 12 sec	29 min 8 sec	44 min 36 sec
100%	32 min	29 min	19 min	36 min	56 min

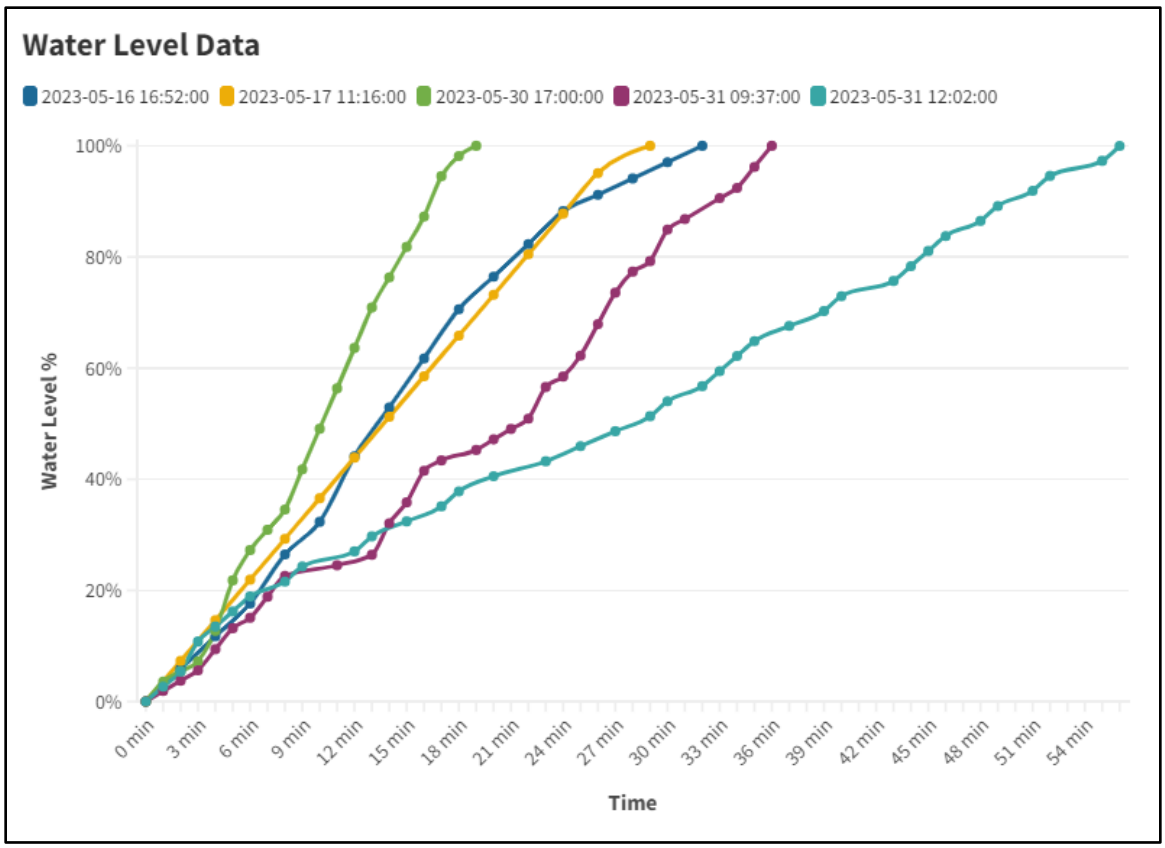


Figure 4.4 Plot of Water Level Data.

The time it took to fill in the water container from 0% to 100% varies from each test as shown in Figure 4.1. Based on the observed data points provided in Table1, the average time it took to fill the water container calculated using the mean is approximately 34.4 minutes for a water container with a 220 liters capacity. This occurrence in the past five most recent processes might be attributed to these factors: the efficiency of the motor, the pressure of the water source, and any potential losses in the system that results in the longer period of the container filling up as shown in the table and figure above. However, the water level sensor can still properly read the level of water in the container, causing it to trigger the motor to fill the gap.

4.2.2. Water Pressure Sensor and the Pressure Difference

Water pressure is crucial to the operation and efficient operation of a fertigation system. This has a direct influence on the accurate distribution of water as well as nutrients to crops as an essential component. Maintaining proper water pressure provides accurate fertilizer delivery, uniform coverage throughout the irrigation system, and, ultimately, efficient nutrient absorption and plant growth.

In the context of a fertigation system, understanding and managing water pressure changes is critical. These pressure differences influence the regularity and efficiency with which nutrients and water are delivered to plants.

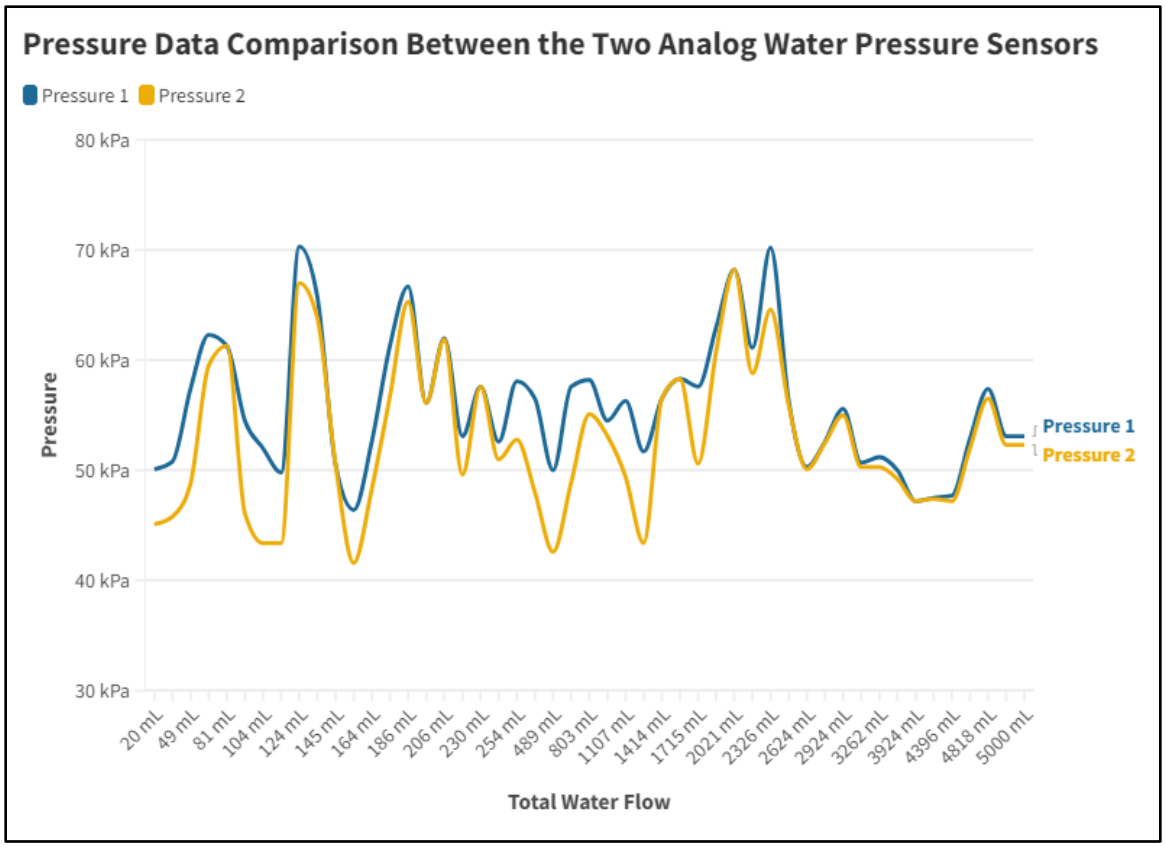


Figure 4.5 Plot of Pressure data from Pressure sensor 1 and Pressure sensor 2.

The venturi fertilizer injector allows the system to mix water with fertilizer for the distribution to crops by following the Venturi effect which utilize a pressure drop between the inlet and outlet of the component to create a suction for the fertilizer. This means that the use of water pressure sensors is crucial to the monitoring of the amount of fertilizer being distributed by the system. Figure 4.2 shows a sample data of the pressure levels (in kPa) collected by the analog pressure sensors of the system over the total water flow of the process. Sensor 1 serves as the pressure sensor at the main assembly's entry point, while Sensor 2 serves in the same capacity at the exit. The diagram clearly shows Sensor 1 reporting a greater pressure level than Sensor 2, indicating an ideal situation for the system.

Table 4.2. t-Test of Pressure Sensors

t-Test: Paired Two Sample for Means

	Pressure 1	*Pressure 2*
Mean	55.90416667	52.9125
Variance	36.04210993	46.04792553
Observations	48	48
Pearson Correlation	0.893737346	
Hypothesized Mean	0	
df	47	
t Stat	6.807546735	
P(T<=t) one-tail	8.00627E-09	
t Critical one-tail	1.677926722	
P(T<=t) two-tail	1.60125E-08	
t Critical two-tail	2.011740514	

The sample water pressure data is tested using Paired Two-Sample t-Test for the hypothesis testing.

Where:

The null hypothesis (H0): There is no significant change between the pressure data collected from the two analog pressure sensors.

The alternate hypothesis (HA): There is a significant change between the pressure data collected from the two analog pressure sensors.

Based on the results of the t-Test, the p-value is less than the significance level of 0.5 rejecting the null hypothesis which indicates a statistically significant change between the pressure data of the sensors. This means that a pressure imbalance exists inside the system, allowing the venturi fertilizer injector to operate whenever the difference reaches 20% or more, rendering it undetected.

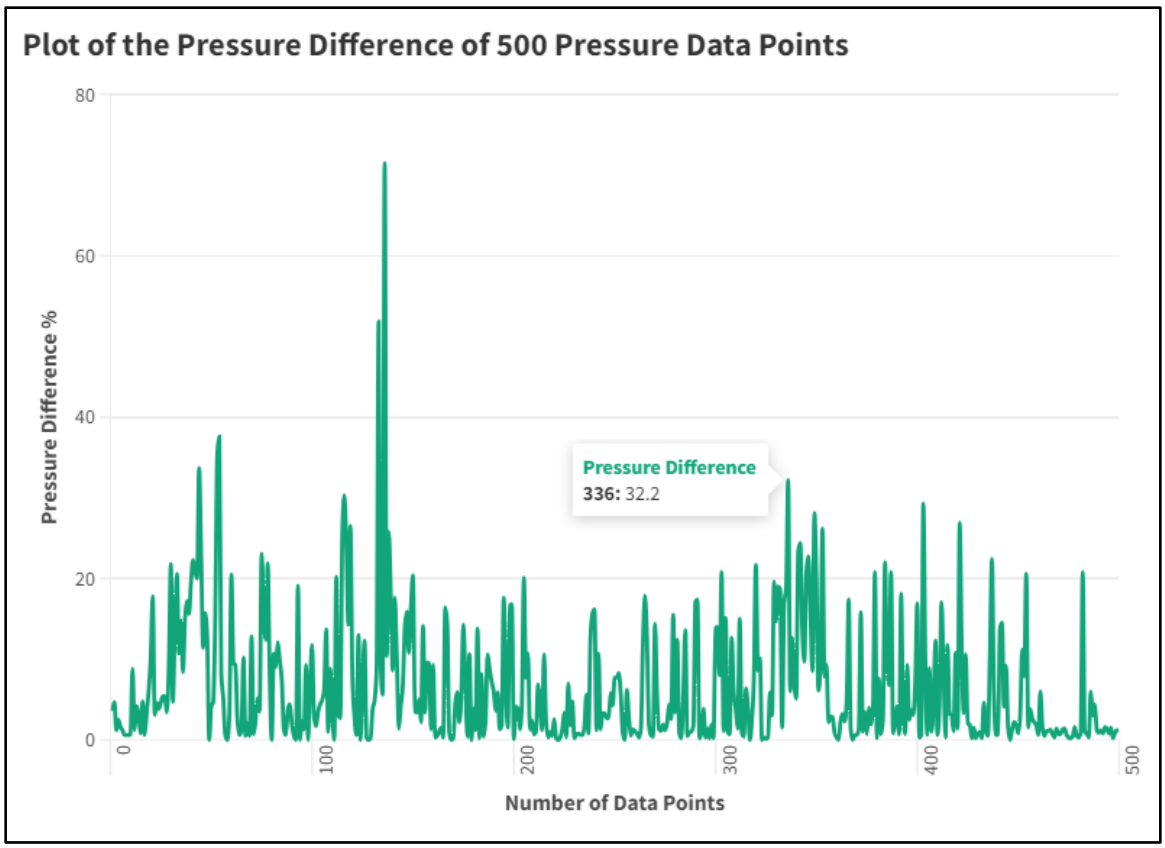


Figure 4.6 Plot of Pressure Difference.

A total of 500 observed data points from the dataset are used as a sample for the observation of the pressure difference between the pressure level data of the analog pressure sensors. As mentioned previously, a difference of 20% or more is essential for the activation of the venturi injector and the consistent application of the fertilizer to the distribution system. The pressure difference is calculated by using the relative change formula:

$$Relative\ Change = \frac{New\ Value - Old\ Value}{Old\ Value} \times 100\ (\%)$$

Each value is then plotted to visualize the variation in the data points. In figure 4.3, the values fluctuate wherein most of the observed values are below 20% difference with some spikes that are around 20% or more which indicates that the activation of the venturi fertilizer injector is possible but is unstable.

Table 4.3. t-Test of Pressure Difference.

t-Test: One-Sample

	Pressure Difference
Mean	6.7294
Variance	64.86464493
Observations	500
Hypothesized Mean	20
df	499
t Stat	-36.84440424
P(T<=t) one-tail	9.0241E-145
t Critical one-tail	1.647912984
P(T<=t) two-tail	1.8048E-144
t Critical two-tail	1.964729391

The statistical method of One-Sample t-Test was used for the hypothesis testing.

Where:

The null hypothesis (H0): The average pressure difference is equal to the expected value range of 20% or more.

The alternate hypothesis (HA): The average pressure difference is not equal to the expected value range of 20% or more.

The results show that the one-sample t-test rejects the null hypothesis because of its extraordinarily low p-value. These findings give strong evidence that rejects the null hypothesis and demonstrates a considerable divergence of 20% or more between the observed and expected pressure discrepancies in the sample. This indicates more proof that the application of fertilizer through the system is not consistent.

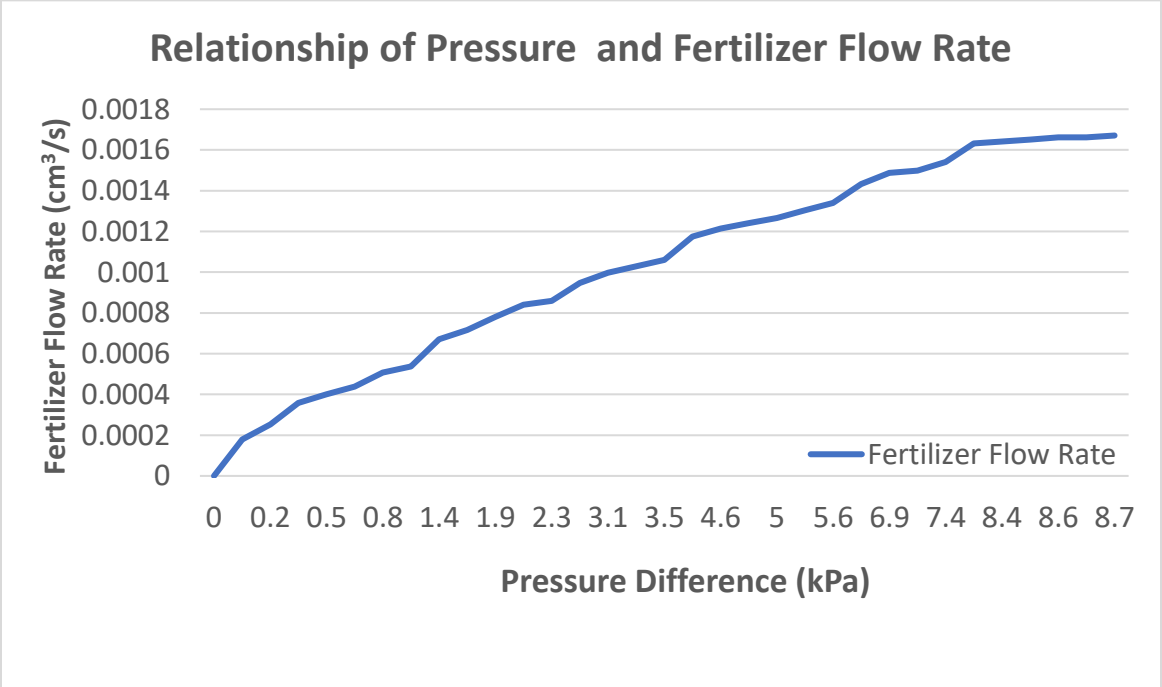


Figure 4.7 Plot of the Fertilizer Flow Rate.

The relationship between the pressure data of the system and the amount of fertilizer that is used in the system is shown in the figure above. The pressure

difference between the two pressure sensors will determine the amount of fertilizer being added in a fertigation process. An ideal pressure difference of 20% will allow the venturi fertilizer injector to consistently draw fertilizer to be added in the system. The data from the pressure sensors in figure 4.5 is utilized in calculating the amount of fertilizer that is flowing through the system. The volume flow rate formula is used to determine the amount of flow rate that is passing through the venturi fertilizer injector by modifying the formula a bit. The volume flow rate formula calculates the quantity of fluid passing through a specific point per unit of time. The formula used is as follows:

$$Q = At * Vt$$

$$Vt = \sqrt{2 * \Delta P / \rho}$$

$$At = \pi * \left(\frac{Dt}{2}\right)^2$$

Wherein,

Q – is the Flow Rate

At – is the Throat Area of the venturi injector

Vt – is the Throat Velocity of the venturi injector

ΔP – is the Pressure Difference

ρ – is the Fluid Density

Dt – is the Throat Diameter of the venturi injector

The results of figure 4.7 shows that the fertilizer flow rate is directly proportional to the pressure difference in the system. The fertilizer flow rate from the data is less than 0.0018 cm^3/s which results to a miniscule amount of fertilizer is being added to the system during fertigation. An increase in the overall water pressure in the system as well as a more precise pressure drop in the outlet of the system is essential in increasing the amount of fertilizer used.

4.2.3. Water Flow Rate

In this part, the proponents concentrate on the measurement and analysis of the water flow rate parameter in the automated fertigation system using the dedicated sensor (FS400A G1 Water Flow Sensor). Water flow rate measurement is critical for determining irrigation efficiency and water consumption trends. Proponents get insights regarding the system's ability to deliver the optimum amount of water to the crops by reviewing the data collected from the water flow rate sensor. This analysis helps to evaluate the performance and optimization of water management inside the automated fertigation system, resulting in more efficient resource consumption and sustainable agricultural practices.

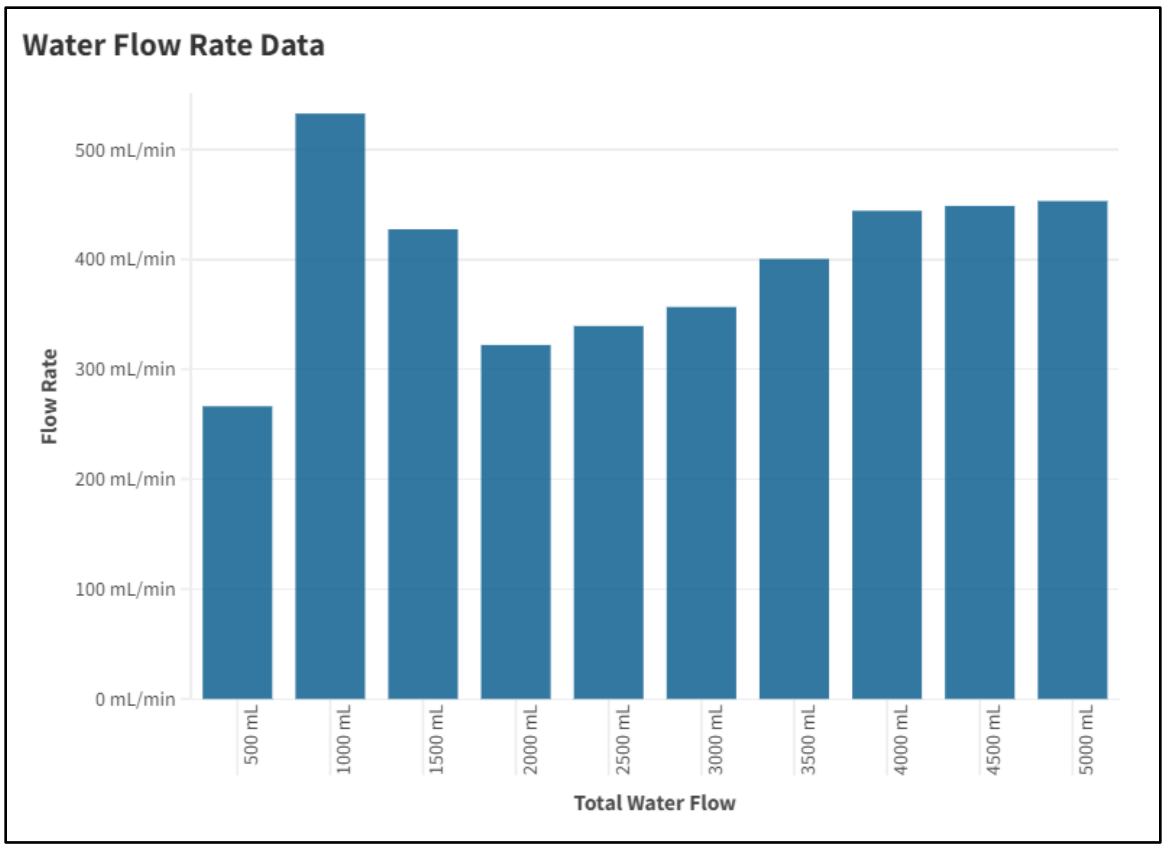


Figure 4.8 Flow rate of the System.

The water flow rate is the amount of water that travels through a certain site in each time period. It is a critical component in the design and operation of the system since it enables intelligent monitoring of the entire water volume going through. It also helps to automatically stop the irrigation or fertigation operation when a certain water level is reached.

Sample data is selected from the dataset to present the average flow rate of the system. Figure 4.4 depicts the initial distribution of water, which shows a progressive range of flow rates ranging from 0 to 500mL. It then achieves its maximum flow rate, which is between 500mL and 1000mL, before dropping back to a lesser flow rate ranging from 1000mL to 2000mL. This reduction happens

when the system achieves its maximum water capacity following the abrupt increase in flow rate between 500mL and 1000mL. Following that, the flow rate steadily increases to a more constant level throughout the operation, suggesting that the distribution system is working well.

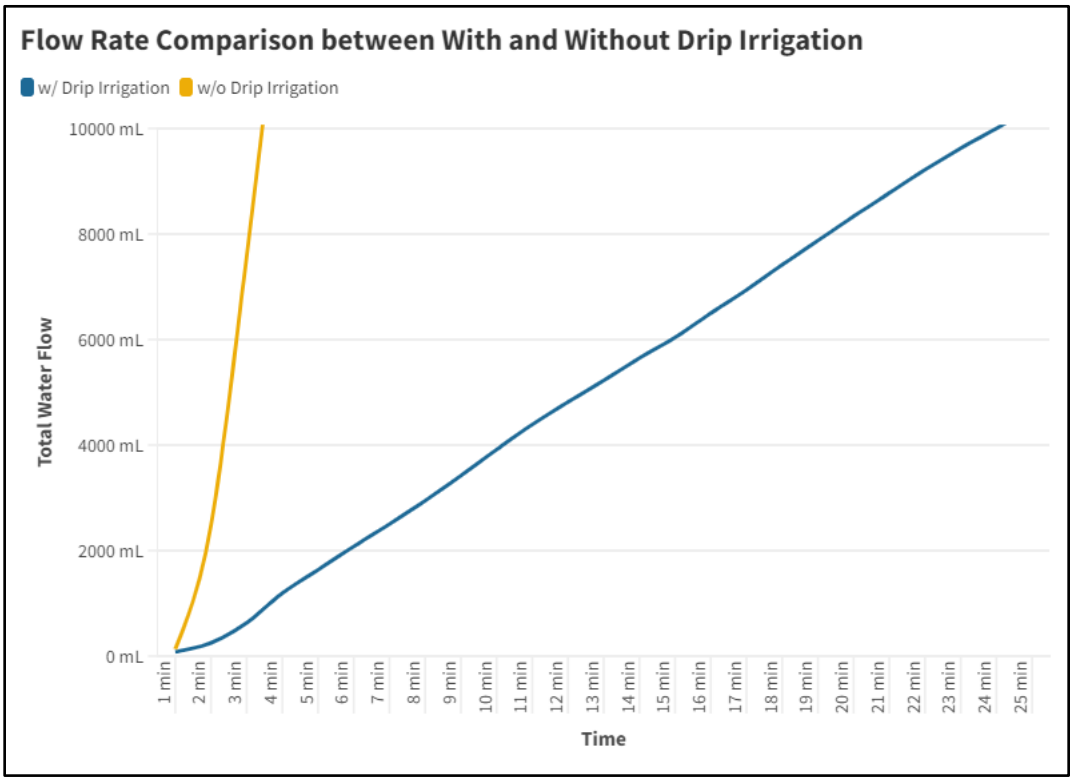


Figure 4.9 Flow rate comparison between With Drip Irrigation and Without Drip Irrigation.

The amount of flow rate of the system is also affected by the inclusion of the drip irrigation system which lowers the value due to having a slower distribution of water in comparison to directly distributing the water out of the pipes. An analysis was undertaken to compare the typical rate of water flow between the

system with drip irrigation and the system lacking it. The research entailed evaluating total water flow during a specified duration using a data sample. The results in Figure 4.5 show a significant difference in the rate of flow between the two procedures. The drip irrigation system took a lengthy time, around 24 minutes, to attain an average flow rate of 10,000 mL. Conversely, the system without drip irrigation reached the same rate of flow milestone in around 3 minutes. This signifies that the process of drip irrigation is indeed a slow method of distributing water to crops but it has the benefits of being a more water-efficient method compared to other irrigation methods.

4.3 User Feedback and System Evaluation

The evaluation of user perspectives and feedback plays a crucial role in understanding the effectiveness and impact of technological implementations. This part presents the results and discussion of user evaluations conducted as part of this research. The purpose of the evaluation was to gather insights from those who interacted directly with the implemented technology, providing valuable information on their experiences, perceptions, and suggestions. By analyzing user rating data, the purpose is to assess users' usability, acceptability, and overall satisfaction with the technology. It also examines the key issues raised by the feedback and discusses the implications for future improvements and recommendations. This is a comprehensive analysis of user ratings to reveal the practical implications of technology and its potential to improve the user experience.

The evaluation was done by eleven (11) people from the deployment area of the system in a farm located in Bustos, Bulacan. These people are those who knows the system or have seen the system and its working processes.

4.2.1. Demographic of the Respondents

The demographic profile of the respondents in this project evaluation comprised individuals from diverse backgrounds, encompassing a range of age groups, genders, and occupational fields. The inclusion of these variables provides valuable insights in the evaluation of this project.

Table 4.4. Demographic Profile of the Respondents.

Age	
10 – 30	4
31 – 50	4
50 and above	3
Gender	
Male	(All respondents)
Occupation	
Farmers	
Drivers	
Students	

Regarding age, the evaluation encompassed respondents spanning various stages of life. Individuals that participated in the evaluation ranged in age from young to middle age to elders. Participants were aged 15 to 57. The inclusion of a

diverse age group is advantageous as it allows for a broader understanding of experiences and perspectives across different generations.

In terms of gender, the study evaluation sample is all men. Since most of the people who work at the farm and have seen the project are all men, hence all the respondents of this evaluation are all men.

The occupational background of the respondents in this study was also diverse. Participants represented a variety of occupations. The survey evaluation was answered by farmers and by students and drivers that is related to the field of agriculture. This broad range of occupations ensures a multifaceted understanding of the research topic, as the perspectives and experiences of individuals from different backgrounds may vary significantly.

4.2.2. Awareness and Familiarity with the Project

At the beginning of the evaluation survey, respondents were asked about their knowledge and/or familiarity of other systems that are like Waterworks-AI. Here are the findings based on the respondents' feedback.

Table 4.5. Familiarity with Existing Technology

	Yes	No
Do you have any prior experience or knowledge about similar technologies?	2	9

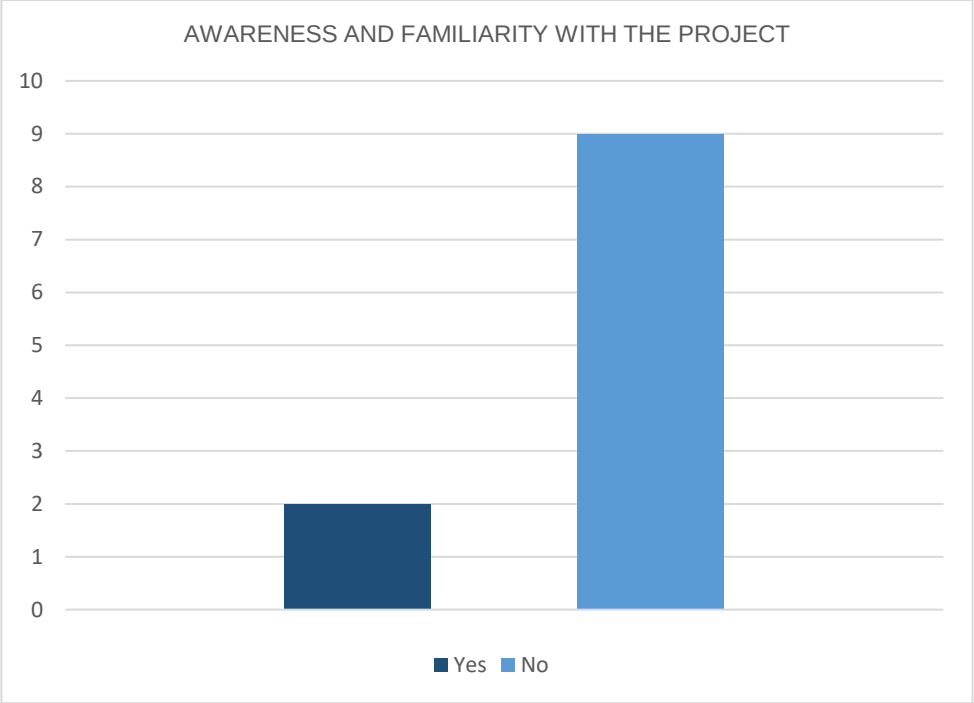


Figure 4.10 Response to the Awareness and Familiarity with the Project.

The survey results show that two (2) out of all respondents (about 18% of the sample) said "Yes" when asked about their prior experience and knowledge of similar technologies. This indicates that a small number of participants have experience with, or have some knowledge of, similar technologies. Their previous experience may be due to personal use, work-related contacts, educational background, or specific interest in the topic.

On the other hand, nine (9) of the respondents (about 82% of the sample), said no, indicating a lack of prior experience and knowledge of similar technologies. The findings suggest that a significant portion of the respondent group is relatively unfamiliar with the technology involved. Limited exposure to similar technologies may influence perceptions, opinions, or decision-making processes related to your research topic.

4.2.3. Technology Evaluation

The proponents delve into the study's technology evaluation element by studying user feedback for the system and mobile app incorporated on it. Understanding user experiences and perceptions is critical for evaluating the fertigation system and mobile application's usability, effectiveness, and satisfaction levels.

Table 4.6. Response Count for Technology Evaluation Question 1.

	Strongly Disagree	Disagree	Agree	Strongly Agree
The automated fertigation system is more convenient than the conventional method.	0	0	11	0

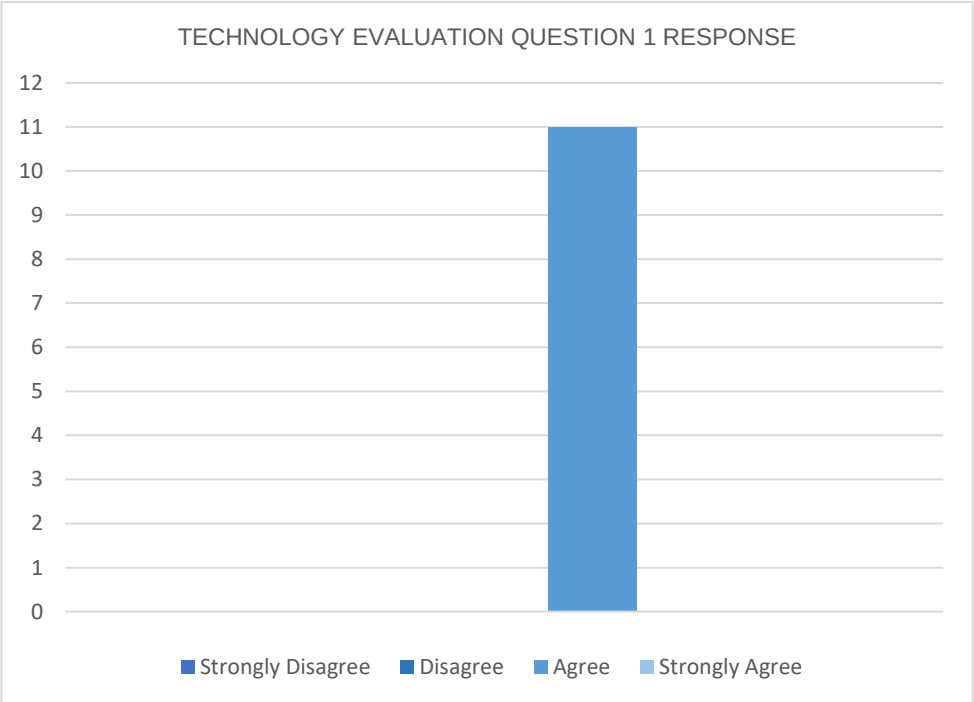


Figure 4.11 Response Count to Question 1.

According to the survey results, all respondents agreed that the automatic fertigation system was more convenient than traditional methods. This result given by the participants indicates a strong agreement on the convenience offered by automated systems compared to traditional approaches. The results suggest that automated fertigation systems offer significant ease-of-use and convenience benefits, potentially saving users time, effort, and resources. This collective agreement reinforces the claim that automated systems offer greater convenience and highlights the potential value and desirability of introducing such technology in the context of fertilization practices.

Table 4.7. Response Count for Technology Evaluation Question 2.

	Strongly Disagree	Disagree	Agree	Strongly Agree
The use of solar panels as a power source is beneficial to the local farmers.	0	0	9	2

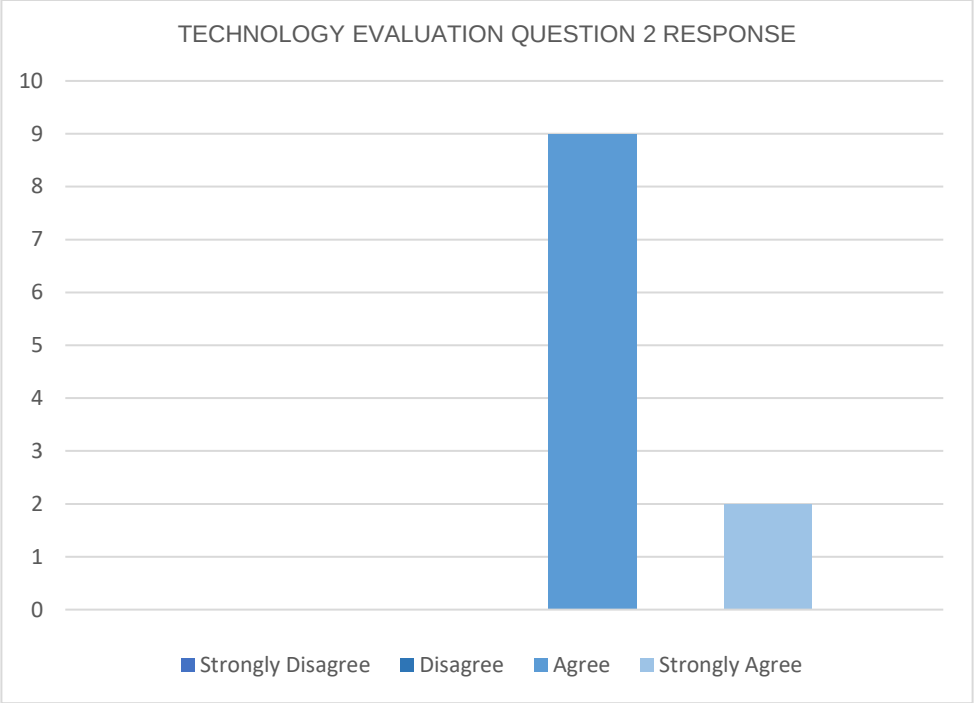


Figure 4.12 Response Count to Question 2.

The responses obtained indicate that most participants of the evaluation agree with the statement. Of all respondents, two participants strongly agreed with this statement, demonstrating their strong belief in the benefits of solar panels for local farmers. Additionally, nine participants expressed their agreement with this statement, suggesting that there is broad harmony among respondents on the positive impact of solar panels on farming communities. These feedbacks highlight the perceived benefits of using solar panels as an energy source. This includes reducing reliance on traditional energy sources, reducing costs, environmental sustainability, and increasing energy efficiency for farmers.

Table 4.8. Response Count for Technology Evaluation Question 3.

	Strongly Disagree	Disagree	Agree	Strongly Agree
The project lessens the cost of maintenance of the irrigation system compared to the previous system used.	0	4	4	3

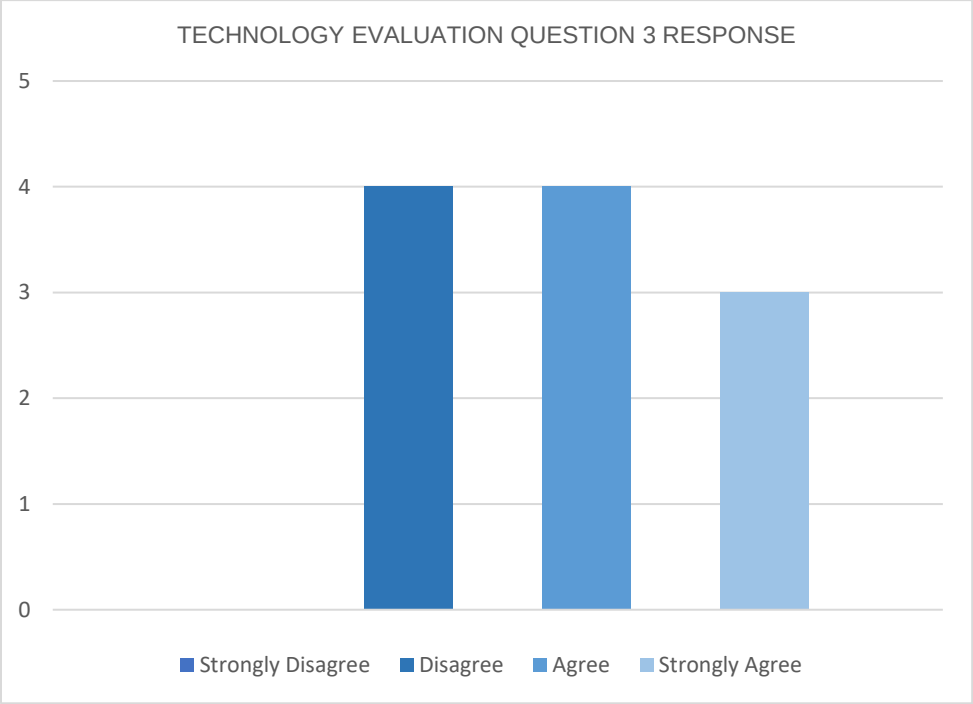


Figure 4.13 Response Count to Question 3.

The results of this statement are categorized as follows:

Four (4) people disagreed with the statement, four (4) people agreed with it, and three (3) people strongly supported it. This reflects a very even distribution of participants' points of view. While there is not a clear winner, the presence of both agreement and strong agreement shows that a sizable proportion of

respondents feel the project significantly cut maintenance costs. However, the disparities in perceptions across different groupings of participants highlight the conflicting views on this issue.

To better understand the underlying factors that influence respondents' perspectives and to understand the impact of projects more fully on the cost of maintaining irrigation systems, the specific rationale for each category of responses should be further analyzed and need to be investigated.

Table 4.9. Response Count for Technology Evaluation Question 4.

	Strongly Disagree	Disagree	Agree	Strongly Agree
The system outputs an accurate amount of fertilizer.	0	1	9	1

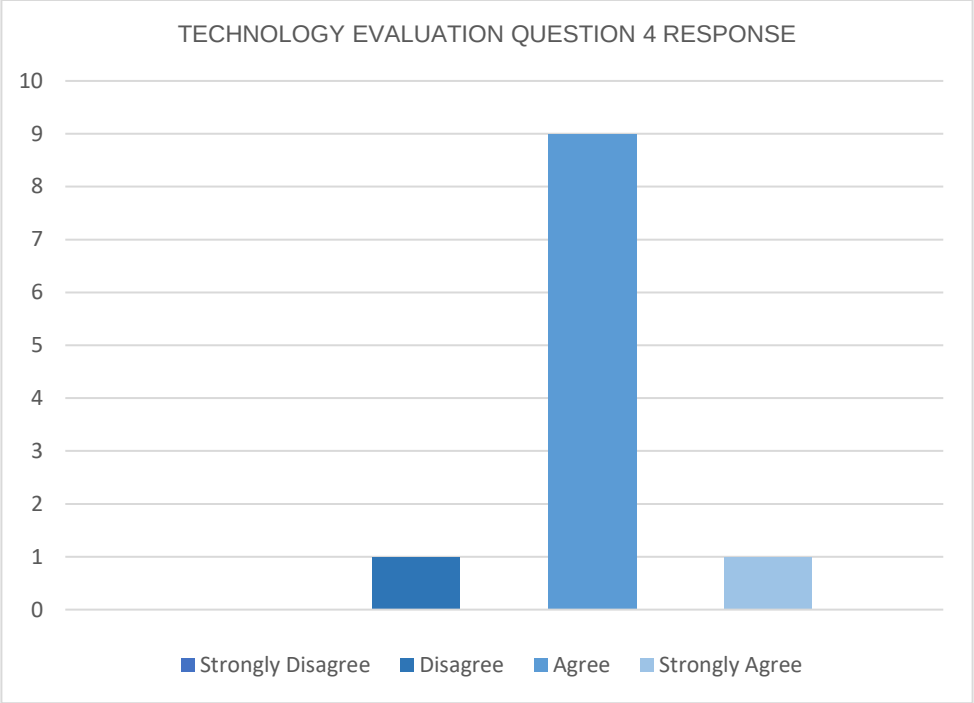


Figure 4.14 Response Count to Question 4.

According to the responses gathered, most participants agreed with the provided statement. Only one person disagreed with the statement, while nine others agreed, and another strongly agreed. These findings suggest that a sizable proportion of participants assessed the system's capacity to reliably predict the appropriate amount of fertilizer favorably.

The agreement and strong agreement responses indicate that the system is believed to be reliable and effective in delivering adequate amounts of fertilizer. However, her one respondent's dissenting opinion indicates that there has at least one person with a different opinion, and perhaps further investigation or indicates that clarification is needed.

Table 4.10. Response Count for Technology Evaluation Question 5.

	Strongly Disagree	Disagree	Agree	Strongly Agree
The system shows many inconsistencies on it.	0	5	6	0

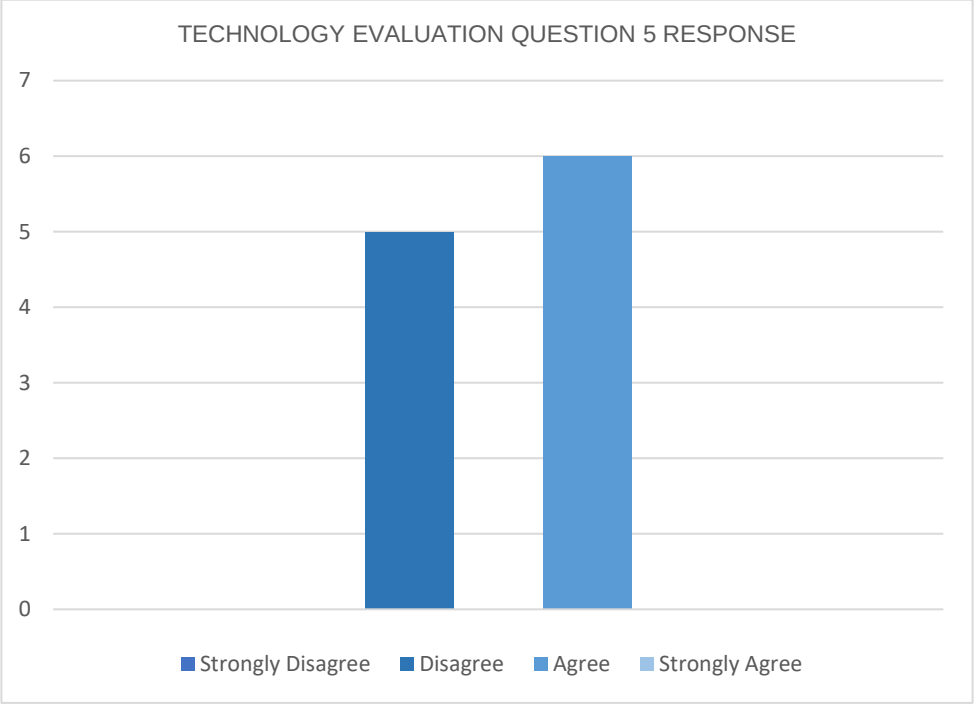


Figure 4.15 Response Count to Question 5.

According to the answers obtained, the views of the respondents were somewhat evenly divided. Six (6) individuals agreed with the statement and stated that the system had numerous irregularities. Five (5) individuals, on the other hand, disagreed with this assertion, suggesting that there were no substantial inconsistencies in the system in their perspective.

This result highlights differences in perspectives within the sample and indicates potential gaps in participants' perceptions of system consistency. Further analysis and research into the specific concerns of the users and understanding the perspective of those who disagree can help identify and resolve conflicts within the system, resulting in a more robust and reliable user experience.

Table 4.11. Response Count for Technology Evaluation Question 6.

	Strongly Disagree	Disagree	Agree	Strongly Agree
The system's function increases efficiency on the farmer's job.	0	0	11	0

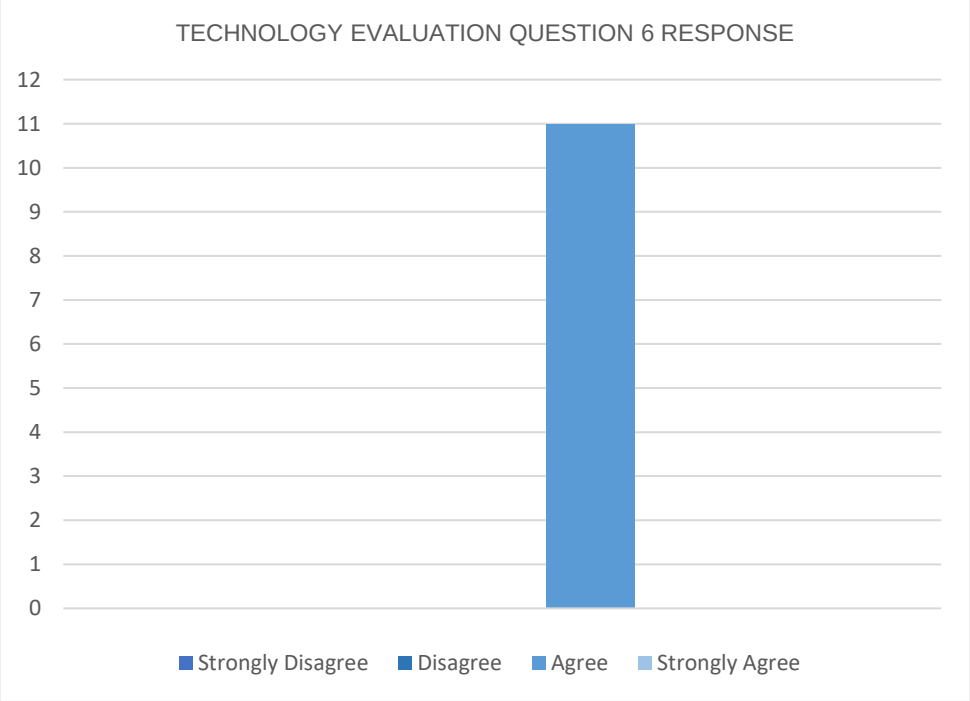


Figure 4.16 Response Count to Question 6.

All participants agreed with this statement based on their responses to this evaluation question. This unanimous agreement indicates that the surveyed system is perceived by the respondents as a valuable tool for increasing farmers' work efficiency. The common response indicates an agreement among the participants and highlights the positive impact of the system on the efficiency of farmers' work. The results highlight the system's potential to streamline processes, automate tasks, and provide useful information that contributes to increased farm efficiency.

Table 4.12. Response Count for Technology Evaluation Question 7.

	Strongly Disagree	Disagree	Agree	Strongly Agree
The system lessens the existing farmer’s workload.	0	2	7	2

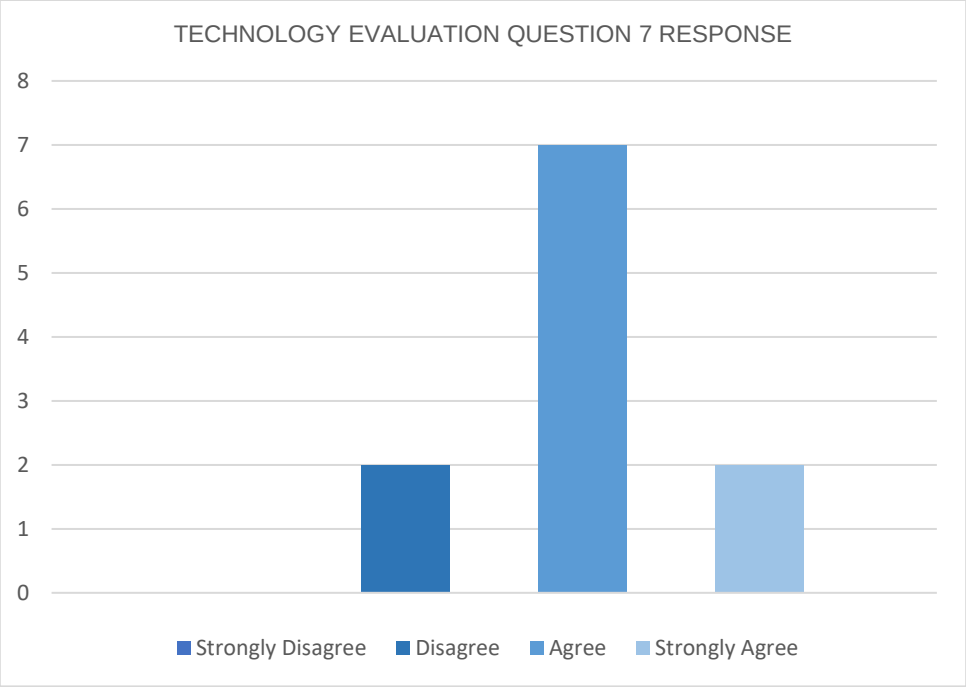


Figure 4.17 Response Count to Question 7.

The majority of respondents agreed with the above statement based on their replies to this assessment question. Seven (7) people agreed, two (2) disagreed, and two (2) strongly agreed. This suggests that a sizable proportion of respondents feel the method helped farmers reduce their burden.

The predominance of agreement and strong agreement suggests that this system is considered effective in reducing the stress and work typically associated with agriculture. These favorable comments suggest that this approach can give real solutions or instruments to expedite the agricultural process and lower farmers' total labor.

Table 4.13. Response Count for Technology Evaluation Question 8.

	Strongly Disagree	Disagree	Agree	Strongly Agree
The project helps in conserving water using drip irrigation.	0	1	9	1

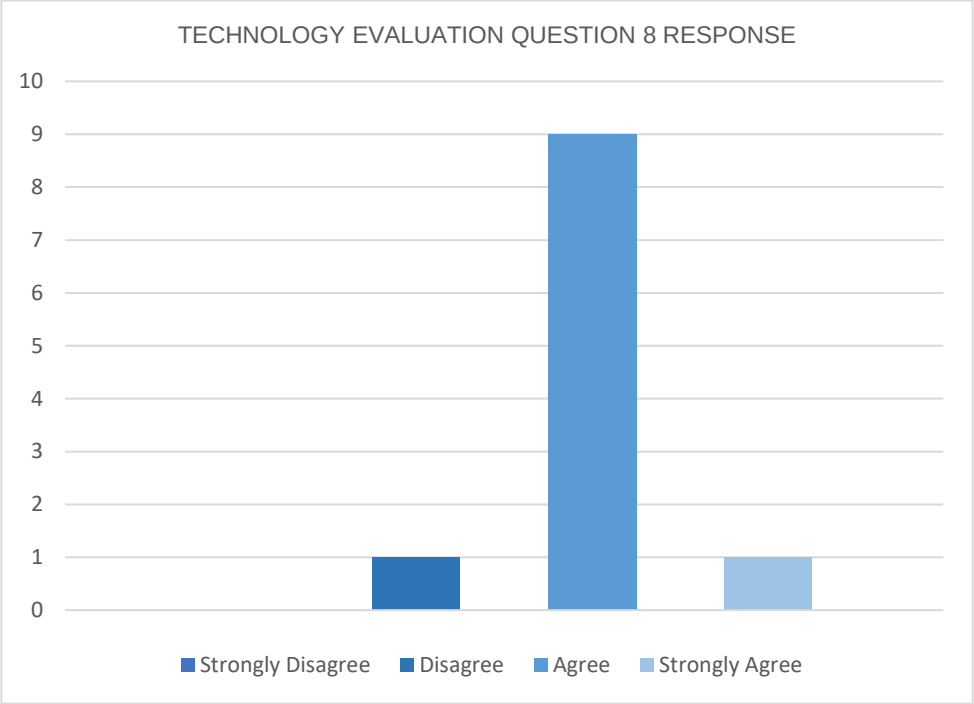


Figure 4.18 Response Count to Question 8.

As a result of this evaluation question, the participants generally agreed. Nine (9) respondents agreed with this statement and one (1) participant strongly agreed. This overwhelmingly positive response highlights the project's perceived effectiveness in saving water through the introduction of drip irrigation technology. Most participants recognized the project's contribution to water conservation and stated that the project successfully used drip irrigation as a sustainable method. The

one (1) respondent who disagreed may have had different views and experiences. The results confirm that the project has a positive impact on water conservation by using drip irrigation as an efficient approach.

Table 4.14. Response Count for Technology Evaluation Question 9.

	Strongly Disagree	Disagree	Agree	Strongly Agree
The reliability of the system is satisfactory.	0	0	10	1

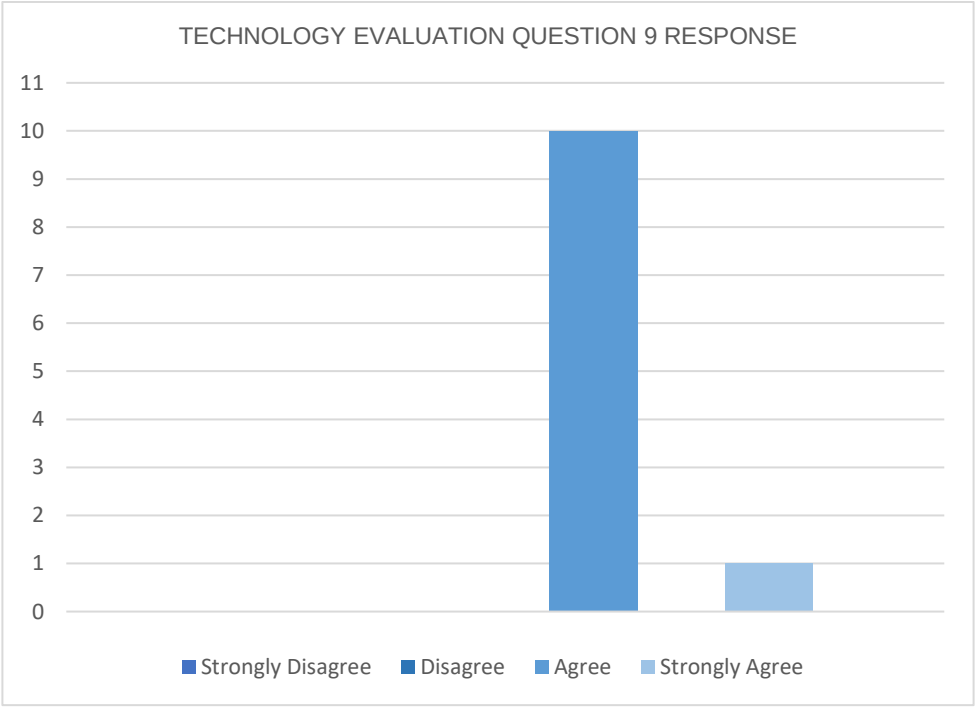


Figure 4.19 Response Count to Question 9.

Based on the data obtained for this statement, the respondents believed that the system is reliable and is satisfied with its reliability. Ten (10) out of the total respondents agree with the statement and one (1) strongly agrees with it. This indicates that all the respondent's perception of the system's reliability is good as all the responses on this statement are on the positive side.

Table 4.15. Response Count for Technology Evaluation Question 10.

	Strongly Disagree	Disagree	Agree	Strongly Agree
The project has a user-friendly interface for the mobile application and is very easy to access and control.	0	0	10	1

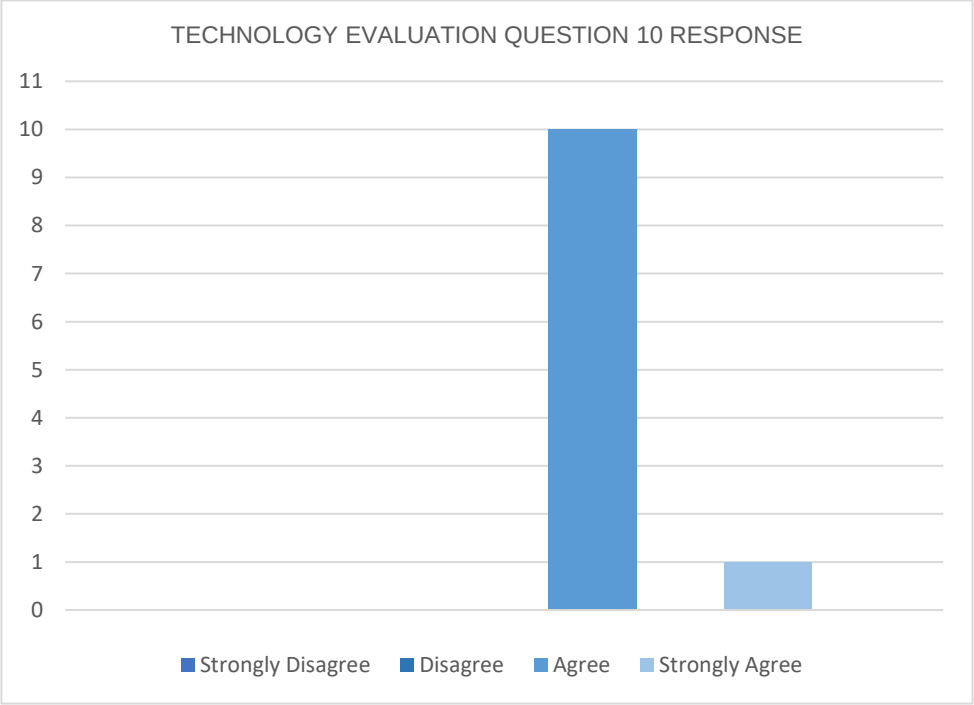


Figure 4.20 Response Count to Question 10.

According to the responses to the assessment questions, most of the respondents agreed with this statement. Ten (10) of all respondents agreed with this statement, with one (1) strongly agreeing. This implies that a sizable proportion of participants found the project's mobile application UI user-friendly and simple to use, indicating a positive user experience. A high number of responses regarding acceptance and completeness indicates that the project has successfully implemented an intuitive and accessible user interface, contributing to a positive perception of application usability and control.

Table 4.16. Response Count for Technology Evaluation Question 11.

	Strongly Disagree	Disagree	Agree	Strongly Agree
The software has all the functions and capabilities I expected it to have.	0	1	9	1

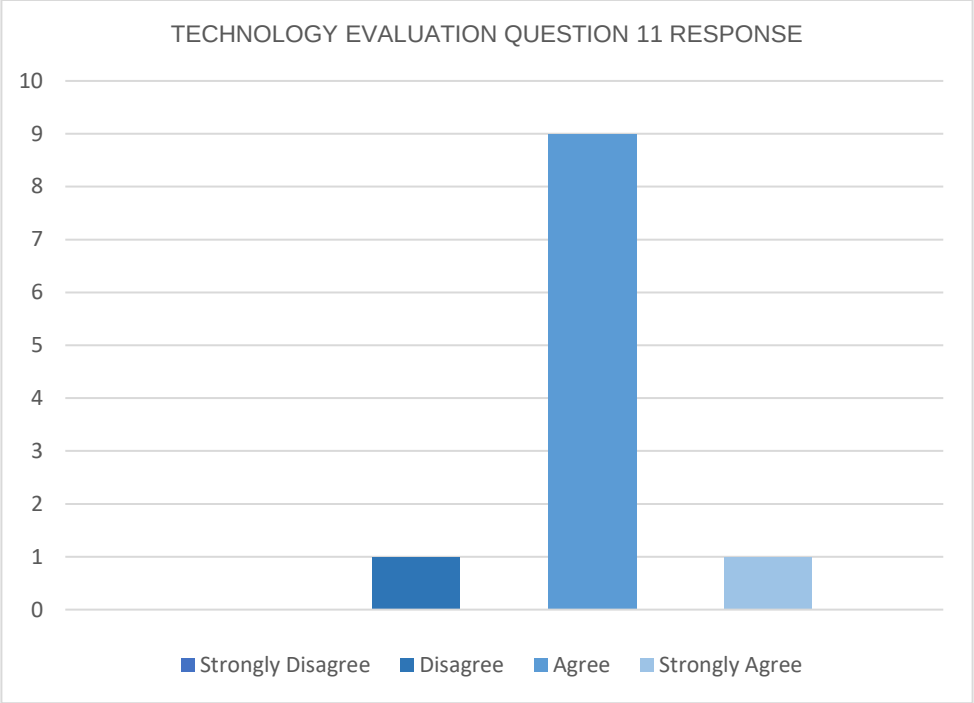


Figure 4.21 Response Count to Question 11.

According to their replies on this assessment question, most participants agreed, with nine (9) agreeing and one (1) highly agreeing. This means that the software met or surpassed the expectations of the participants in terms of functionality and capabilities. Positive feedback indicates that the software meets the expected requirements and provides the required functionality.

However, one (1) of the participants disagreed with this statement and had different expectations or felt that the software lacked certain areas. The different responses underscored the importance of considering individual differences in expectations and experiences, and the software's ability to address the concerns expressed by different respondents may have room for improvement or further investigation. suggests that there is

Table 4.17. Response Count for Technology Evaluation Question 12.

	Strongly Disagree	Disagree	Agree	Strongly Agree
I can easily add and/or delete irrigation or fertigation schedules.	0	1	8	2

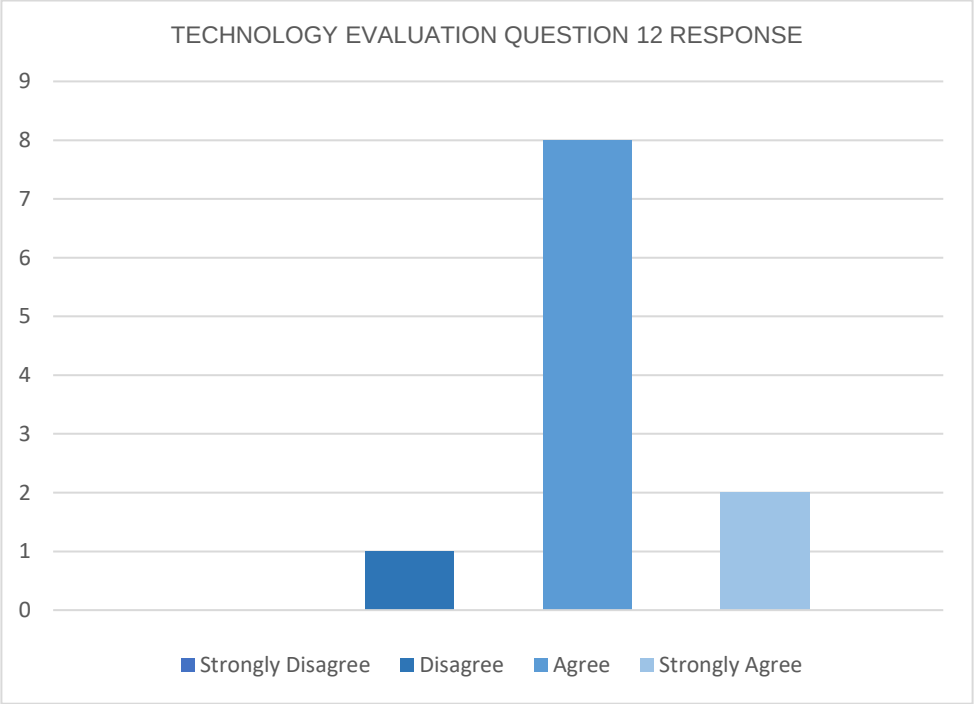


Figure 4.22 Response Count to Question 12.

Eight (8) respondents agreed with this statement and said it was relatively easy to add and/or remove irrigation or fertilization schedules. Additionally, two (2) respondents fully agreed and expressed a high level of confidence and ease in performing this task. One (1) responder disagreed, stating that it is difficult to modify or eliminate irrigation and fertigation schedules. These replies illustrate a variety of perspectives, with the majority reporting easy and a minority indicating

considerable difficulty. Most respondents consider adding and/or removing irrigation or fertigation schedules as a manageable process that implies a positive user experience and ease of use for the system in question.

Table 4.18. Response Count for Technology Evaluation Question 13.

	Strongly Disagree	Disagree	Agree	Strongly Agree
The gathered data of the system are very helpful.	0	0	9	2

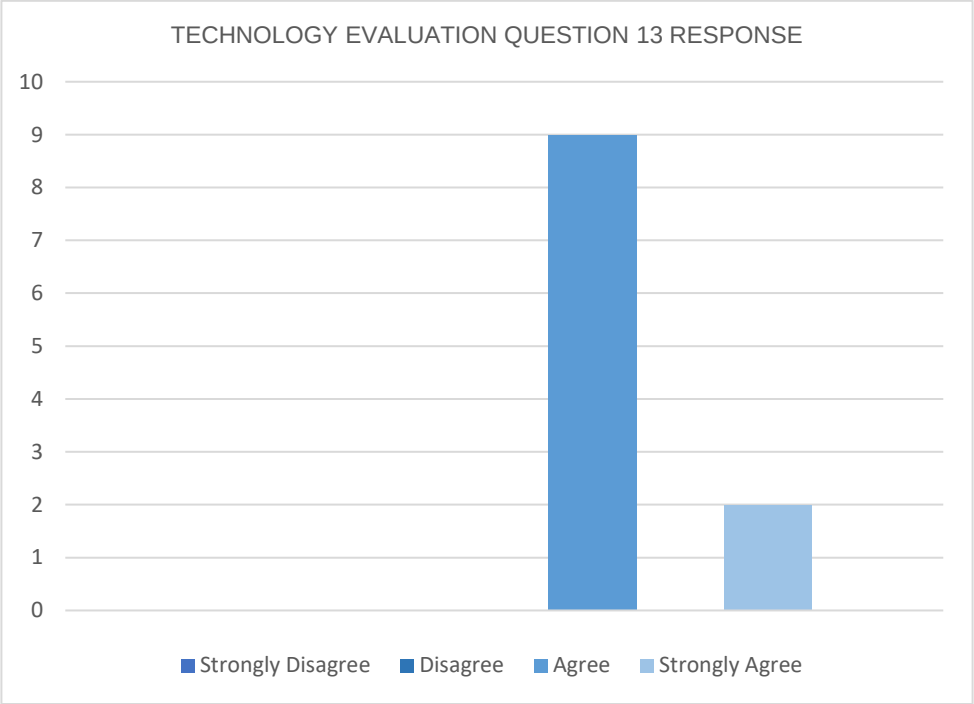


Figure 4.23 Response Count to Question 13.

The data collected by the system has proven to be quite useful, as seen by feedback from evaluation participants. Out of the whole response pool, nine people agreed that the data was valuable, while two people agreed completely. The replies

indicate that the information gathered is valuable and provides relevant insights or support for the desired goal.

Table 4.19. Response Count for Technology Evaluation Question 14.

	Strongly Disagree	Disagree	Agree	Strongly Agree
This project is useful to the overall work of the local farmers.	0	0	10	1

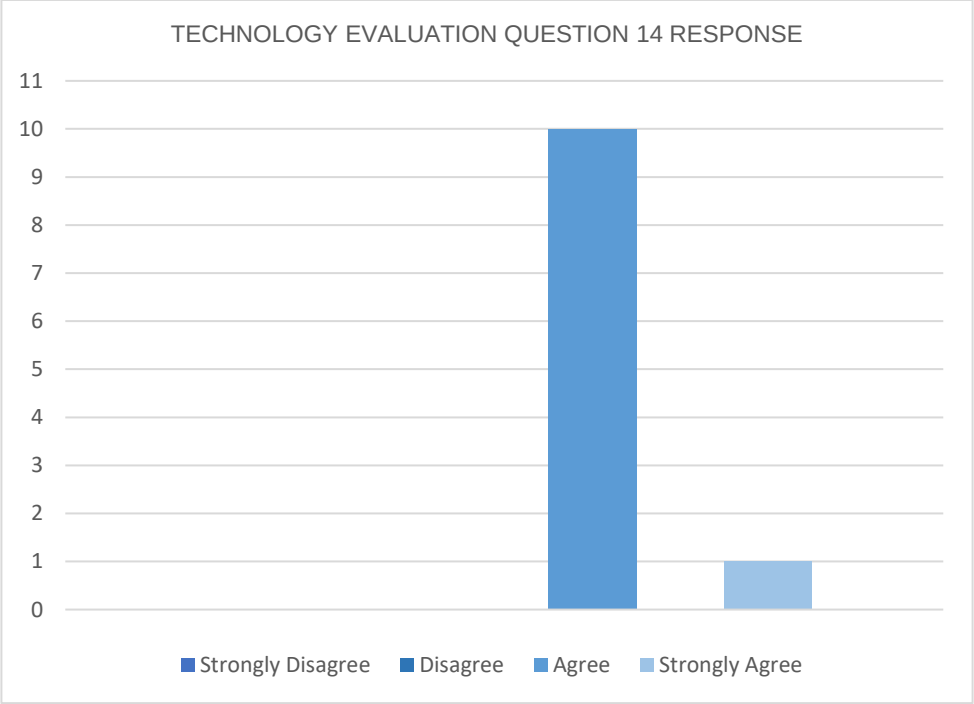


Figure 4.24 Response Count to Question 14.

Ten (10) respondents agreed, with one (1) strongly agreeing, indicating that the project is considered very beneficial to the overall work of local farmers. This high level of approval suggests that the project is of significant value and relevance

to the local farming community. The unanimously positive response was that the participants were aware of the potential of the project to positively contribute to the work of local farmers, bringing practical benefits, addressing challenges, and improving farming practices.

Table 4.20. Response Count for Technology Evaluation Question 15.

	Strongly Disagree	Disagree	Agree	Strongly Agree
This project gives me satisfaction by its performance.	0	0	10	1

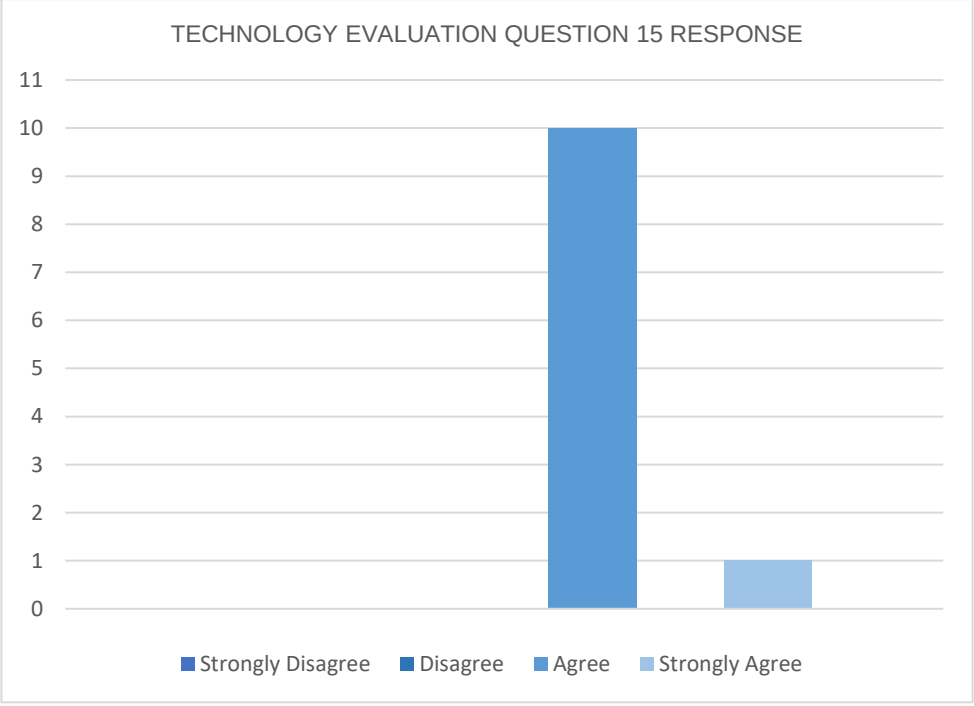


Figure 4.25 Response Count to Question 15.

Most evaluation responses to this question indicated that the project performance was satisfactory to the participants. With ten (10) respondents agreeing and one (1) strongly agreeing, this project meets or exceeds expectations for satisfactory performance. The absence of any disagreement further strengthens confidence that the project has successfully achieved its intended results, leading to higher satisfaction among respondents.

Table 4.21. Response Count for Technology Evaluation Question 16.

	Strongly Disagree	Disagree	Agree	Strongly Agree
I feel comfortable using this system.	0	0	10	1

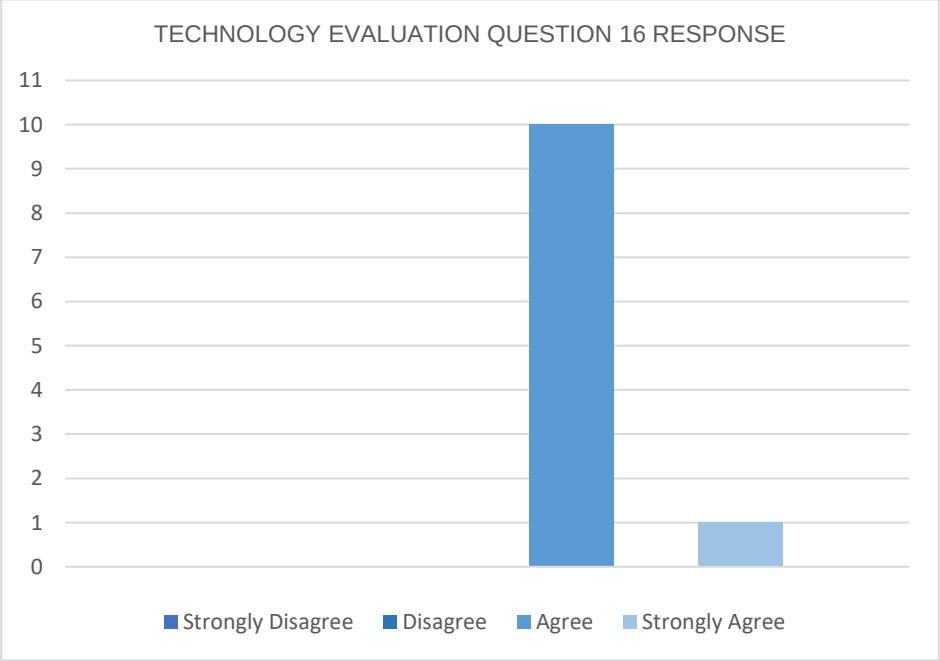


Figure 4.26 Response Count to Question 16.

The answers of respondents (10 agree, 1 strongly agree) show that users are quite comfortable using the system. This good response indicates that the system is user-friendly and intuitive, that it satisfies the requirements and expectations of the users, and that it fosters comfort and trust in its ease of use.

Table 4.22. Response Count for Technology Evaluation Question 17.

	Strongly Disagree	Disagree	Agree	Strongly Agree
The project can be used for a long period of time in mind.	0	0	9	2

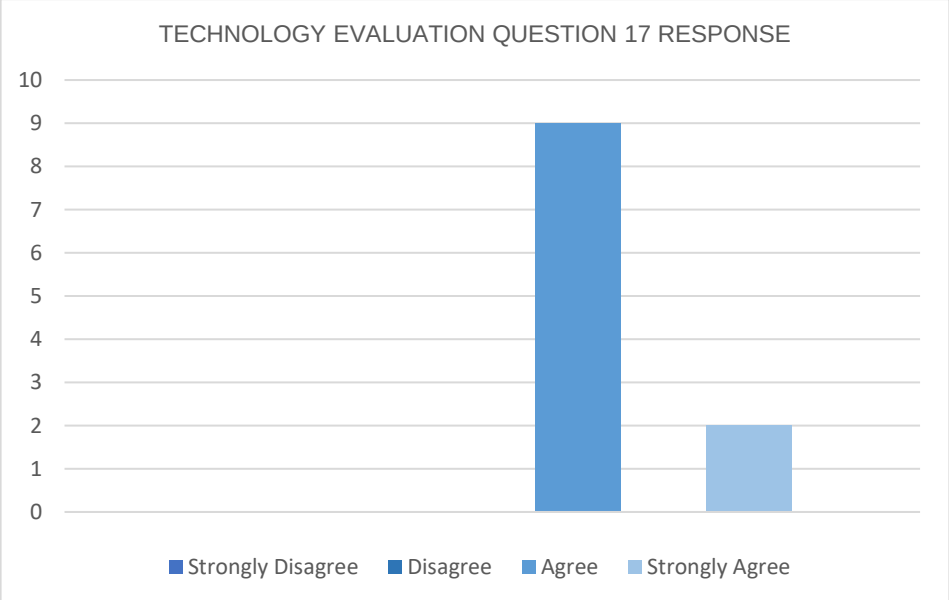


Figure 4.27 Response Count to Question 17.

The majority of the nine people who took part agreed, and two strongly agreed, that the project could be utilized indefinitely. This reflects a general view

among participants that the initiative is designed to last and has the potential to be a long-term solution. The large percentage of 'agree' and strongly agree' replies implies a strong belief in the project's long-term viability. This good feedback lends credence to the notion that the project's design and execution methods are well-equipped to withstand the test of time and assure long-term utility and effectiveness.

Table 4.23. Response Count for Technology Evaluation Question 18.

	Strongly Disagree	Disagree	Agree	Strongly Agree
Through this project, it lets me widen my technological perspective.	0	0	9	2

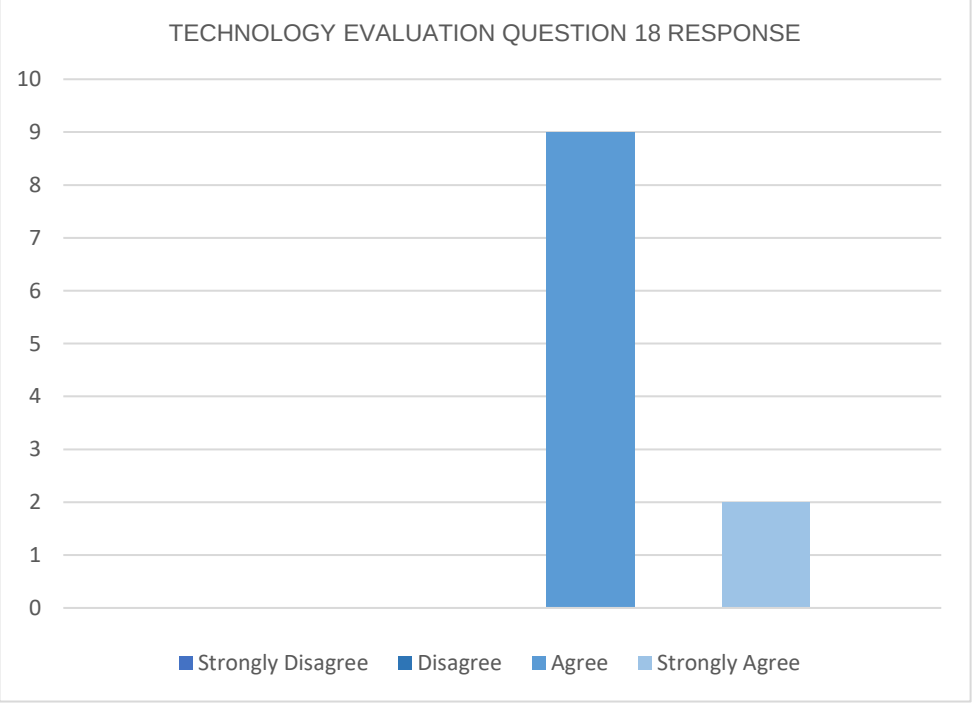


Figure 4.28 Response Count to Question 18.

Data collected for this question show that most respondents, nine (9) agreed with this statement, with two (2) respondents strongly agreeing. This shows that the project succeeded in broadening the technical horizons of the participants. Positive responses indicate that the project provided valuable learning opportunities and access to new technologies, and enabled respondents to increase their knowledge and understanding of the technology field. This agreement and strong agreement indicate a high level of satisfaction among the users and highlights the effectiveness of the project in achieving the goal of improving the technical perspective of the stakeholders.

Table 4.24. Response Count for Technology Evaluation Question 19.

	Strongly Disagree	Disagree	Agree	Strongly Agree
I will recommend this project to other local farmers I know and work with.	0	0	9	2

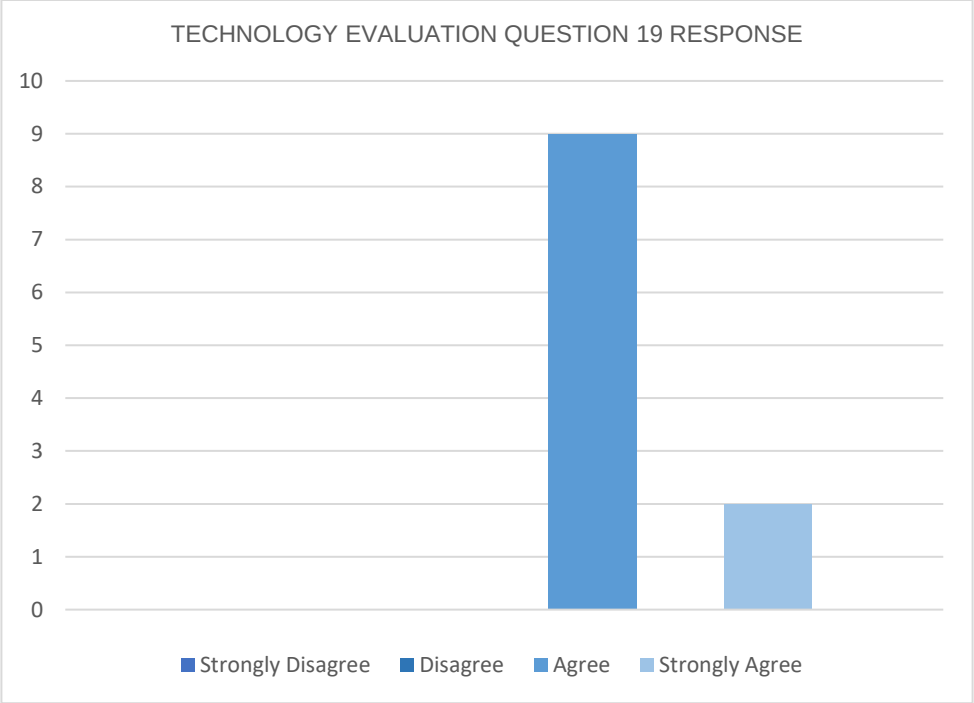


Figure 4.29 Response Count to Question 19.

There was strong agreement among respondents to this statement, with nine (9) participants agreeing and two (2) participants strongly agreeing. This high level of approval indicates that the project has received a positive response from those interviewed, who expressed their strong will to support and promote the project within their network of local farmers. doing. The overwhelming majority of respondents who agreed or strongly agreed indicate a high level of confidence in the potential benefits and value of the project for other farmers in the region. This positive endorsement means that the project is more likely to go viral, project details may be disseminated, and there may be greater acceptance and opportunities for collaboration among local farmers. The enthusiasm and support expressed by the participants highlight the potential impact of this project and its ability to address the common needs and interests of the farming community.

Table 4.25. Response Count for Technology Evaluation Question 20.

	Strongly Disagree	Disagree	Agree	Strongly Agree
The project fits perfectly with the needs of the farm.	0	0	11	0

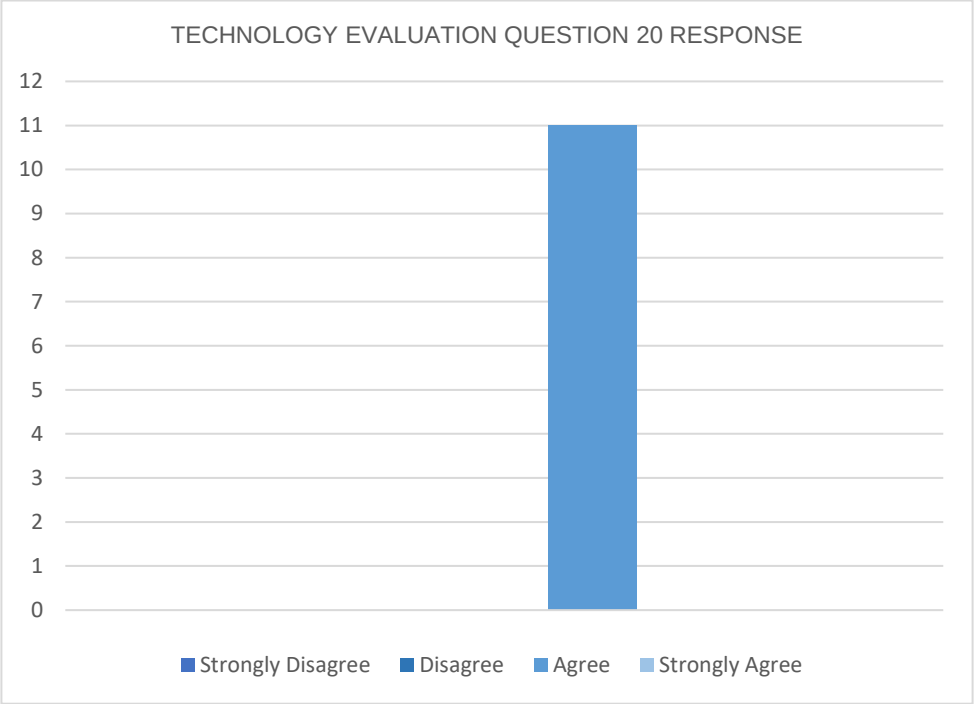


Figure 4.30 Response Count to Question 20.

All respondents unanimously agreed with this evaluation question. The results demonstrate a high degree of consensus among the participants regarding tailoring the project to the specific needs and requirements of their operations. Unanimous approval indicates that the project design, objectives, and proposed solutions are considered highly suitable and have been customized to effectively meet operational needs. This positive response is a strong sign that the project

aligns well with the company's goals and may well address challenges and goals. This is invaluable evidence that the project is on the right track and has strong support from survey respondents, giving confidence that the project fits the specific needs of the operation.

Table 4.26. Rating summary given by the evaluators.

Technology Evaluation				
Statements/Questions	Strongly Disagree	Disagree	Agree	Strongly Agree
NO.01	0	0	11	0
NO.02	0	0	9	2
NO.03	0	4	4	3
NO.04	0	1	9	1
NO.05	0	5	6	0
NO.06	0	0	11	0
NO.07	0	2	7	2
NO.08	0	1	9	1
NO.09	0	0	10	1
NO.10	0	0	10	1
NO.11	0	1	9	1
NO.12	0	1	8	2
NO.13	0	0	9	2
NO.14	0	0	10	1
NO.15	0	0	10	1
NO.16	0	0	10	1
NO.17	0	0	9	2

NO.18	0	0	9	2
NO.19	0	0	9	2
NO.20	0	0	11	0
TOTAL	0	15	180	25

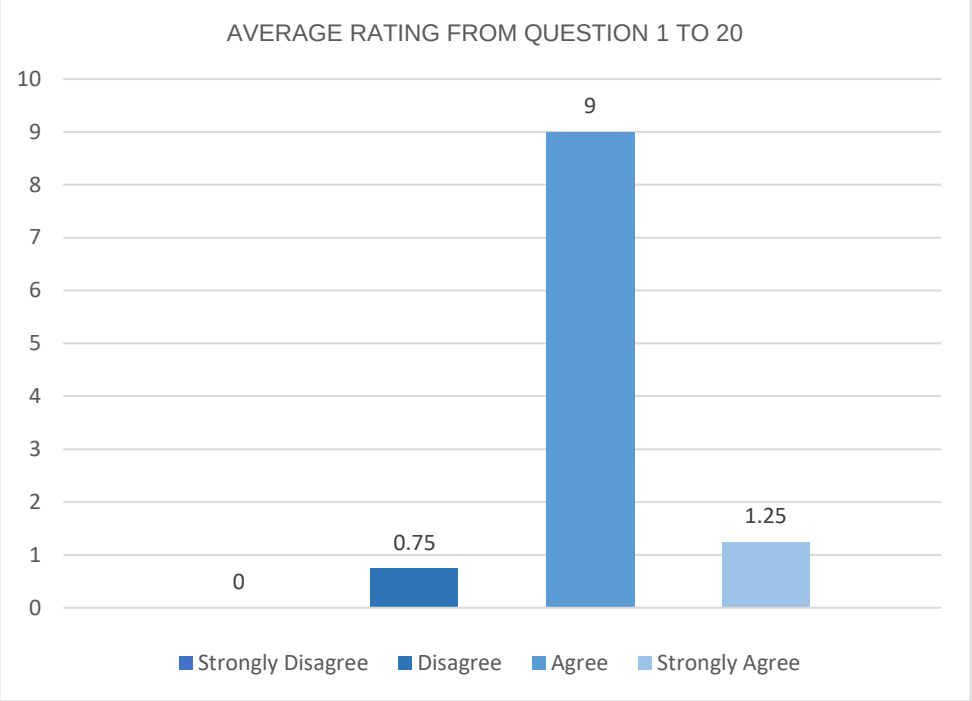


Figure 4.31 Average of Score Rating.

The average of responses received on each scale provides a quantitative measure of the respondent's overall disposition towards the system. The scale in the above instance goes from "strongly disagree" (0) to "strongly agree" (1.25), and "disagree" (0.75) to "agree" (9). We may estimate the overall degree of disagreement or agreement with each statement in the evaluation survey by averaging each scale.

It is important to note that average scores provide an overall overview and do not capture individual distinction or variations in responses. This serves as an overview measure of the overall sentiment expressed by the respondents to the statement in question.

4.2.4. Benefits and Impacts

Table 4.27 Translated Responses for the Benefits and Impacts Question

What are the possible benefits and impacts of this project in your field of work?	● The work of the farmer will get easier, and it will reduce the cost. ● It will speed up the work. ● Physical work will be reduced and irrigation with technology will be easier. ● The work is made easier or faster. ● It can make the work of the farmer easier. ● It will make our (farmers) work easier and faster. ● One of the benefits is that we do not have to use the crude oil that we use almost every day. ● It will speed up the process of irrigating the vegetables. ● It makes the work in the farm (in Tumana) easier. It reduces work time and allows you to do other things. ● It will save us time to go to the farm by ourselves. ● It will help us lessen the workload in the farm.

The responses received from the survey point to some key points related to the perceived benefits of the project. Majority of the respondents highlighted the potential of projects to make farmer's work easier, faster, and more efficient. They stressed that the project would reduce manual labor, reduce costs, and speed up various agricultural processes such as irrigation. Additionally, some respondents

pointed to environmental benefits, particularly reduced oil consumption, while others noted potential time savings by not having to drive to the farm.

Overall, responses indicate a positive perception of projects focused on improving work efficiency on farms, reducing manual labor, and increasing productivity. The potential benefits stated are consistent with the objectives of the project, suggesting that it may have a positive impact on the farming community and effectively meet its needs.

4.2.5. Suggestions and Improvements

Table 4.28 Translated Responses for the Suggestions and Improvements Question

Do you have any specific features or functionalities you would like to see added or modified?	● Upscale the motor. ● Upscale the project. ● High quality materials and original parts and improve the mechanism. ● Upscale the motor and the hose. ● Upscale the motor. ● Used bigger motor to make the water suction stronger. ● Increase the size of the used motor. ● Use a larger motor. ● It has a good objective and was a great help to farmers. ● Buy a higher quality motor for greater water pressure. ● Upscale the motor.

The responses received in the evaluation show a consistent theme centered around upscaling or improving the motor used in the project. Several participants said the motor needed to be improved, either by increasing its size or by using a

larger motor overall. The bigger motor looks to be intended to boost water suction and pressure to enhance efficiency and performance. Furthermore, it is recommended to utilize high-quality materials and original parts, as well as pay particular attention to strengthening the mechanism, to ensure longevity and dependability.

The reactions were mostly favorable, with participants acknowledging that the project's aims are good and advantageous to farmers. Proposals to upscale the motor and improve its performance are consistent with the goal of optimizing the effectiveness of the project to meet the needs of the target group.

Overall, the responses emphasize the importance of upsizing the motor and using quality components to achieve the desired results in your project.

4.2.6. Usage and Adoption

Table 4.29 Translated Responses for the Usage and Adoption Question

How likely is it for you to do a transition and use/adopt the project?	● 99.9% because it reduces work and expenses. ● The chance is high. ● 100% because it speeds up the work and this involves technology and will expand the system. ● At the moment there is no plan to use this technology. ● The chance is great because it is a big deal for farmers. ● We are not used to it yet, but when we learn it well, we can adapt to it. ● When we see that the water pressure gets stronger. ● I would prefer an automatic watering system because it would make the job easier. ● If this project goes well and can be improved. We agree to use it.

	● I am positive that we can use it if the system is proven to be durable for a long time. ● There is a chance that we can make a transition to this automatic system.

Based on the responses in the ratings, there is a positive sentiment toward implementing the proposed technology. Most respondents said the technology offers benefits such as reducing labor and costs, speeding up work, expanding systems, and making work easier. The results show an agreement that there is a willingness to adopt and transition to an automated system if the project proves successful and durable. Some respondents acknowledged their inexperience with the technology but expressed a willingness to learn and adapt.

Overall, the responses show a positive outlook on the technology's potential implementation, focusing on its practical benefits and opportunities offered to improve the efficiency of agricultural operations.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

This chapter presents the summary of the results and conclusion of the study. This also presents the recommendations drawn by the proponents from the results and limitations of the study.

5.1. Summary of Findings

This section presents the summary of the results of the study undertaken on the development of an automated fertigation system utilizing drip irrigation method with partner android mobile application. The results of the study are summarized as follows.

The power source for the control system's overall operation is a battery and solar panels. This system has the primary control circuit, which oversees keeping track of the entire procedure and disseminating information and commands to the various electronic components of the whole system.

The use of solar power as an energy source provides various benefits, including reduced dependency on traditional power systems and a lower carbon footprint. Water-related sensors allow for the monitoring of parameters under the same label (level, flow, and pressure), allowing for more precise and targeted irrigation and fertilization.

The use of solenoid valves controlled by microcontrollers as sensor nodes enable automated and controlled water and fertilizer delivery. This maximizes resource usage and reduces manual intervention, saving farmers and producers time and labor expenditures.

The system performance of the automated fertigation system also relies on the operation of its main sensing unit which includes water level senor, water pressure sensor, and water flow rate sensor. Based on the results, the time the system takes to fill a 220-liter capacity container is around half an hour in average. Although it takes longer than the expected, the water level sensor still precisely collected the data needed to make the analysis of the water level possible. The measurements of the pressure sensors proved that it is working but still has some inconsistencies with it. The flow rate was also measured by the system. The setup with drip irrigation shows slower flow of water compared to the setup without drip irrigation. This means that the flow rate shows more conservation of water in the setup with drip irrigation compared to none.

The user evaluation reflects the current outlook of the local farmers to the system deployed by the researchers in a farm in Bustos, Bulacan. Most of the are not familiar with the system. After knowing and seeing the system, the evaluation shows favorable results for the researchers as the evaluators give an average of an agree rating to the system. For question or statement 1 to 20, most of the answers or responses agrees to it. Most of their suggestions circle around upscaling the project. They thought that having this kind of system only makes their farming lives more convenient and easier. Lastly, when asked about adopting or transitioning to this technology, some gives a positive response but some are still less confident on it.

5.2. Conclusion

This section summarizes the research objectives stated in the introduction and provides a detailed analysis of the findings and implications of the inquiry into an

automated fertilization and irrigation system connected with a mobile app. The proponents not only realize the basic study objectives, but also remark on the larger associations of the findings, suggest areas for future research, and explore the practical consequences of adopting such a system in real-world circumstances.

Based on the findings and results of the study, the following are the conclusions drawn out by the proponents:

1. The proponents developed a solar-powered fertigation system that automates the distribution of liquid fertilizer to field crops. It also utilizes the Venturi effect of the fertilizer injector in an automated irrigation system. This system effectively absorbs and mixes Triple 16 Urea fertilizer with irrigation water from a deep well. By using the solar-powered automated fertigation system, farmers can reduce environmental and financial impacts without compromising crop quality or quantity. The integration of accurate flow control and metering equipment with open-source platforms like Arduino increases accessibility and customization options for farmers and researchers worldwide.

2. A water source system was successfully constructed for the automated fertigation system, utilizing a 12V DC solar water motor pump. The system had a flow rate of 1.5m3/H and could transfer water from the 15-meter (49.21 ft.) deep well to the alternative water source, an HDPE drum. Using a deep well as the primary water supply offered advantages such as abundant groundwater resources and reduced dependence on external water sources. The power management system implemented in the solar-powered water supply system allowed for efficient operation. A manual

switch was installed to enable users to manually control the water pump when needed. The water level in the container was monitored using JSN-SR04T ultrasonic level sensors, and the collected data was saved in a database.

3. A user-friendly mobile application was developed using Android Studio, PHP, phpMyAdmin, and Visual Studio Code. Farmers can input irrigation schedules, monitor system performance, and manage data. The mobile application is user-friendly and performs tasks such as reading sensor data, processing schedules, and storing information in a centralized database. This integrated solution enables users to make informed decisions about irrigation scheduling and nutrient distribution, improving efficiency and sustainability in agriculture.

4. The proponents conducted rigorous testing, including simulations, calibration, and field testing, to assess the system's performance and reliability. Feedback from farmers and potential users in San Pedro, Bustos, Bulacan, obtained through surveys and evaluation questionnaires, indicated that the system showed promise with most respondents agreeing that it has potential for improvement. They appreciated the idea of automating fertigation to reduce workload and expressed willingness to adopt the technology in the future if it becomes more stable and upscaled.

5.3. Recommendations

This section presents future work recommendations based on the study's findings and limitations on the automated fertigation system with a mobile application. As with any

study project, the investigation found areas that merit additional investigation and development. Researchers and practitioners can continue to advance the field of automated fertigation and improve its practical applicability in agricultural settings by considering these recommendations.

Based on the findings and conclusions presented, the following recommendations are suggested:

1. Consider adding nutrient-level monitoring feature. This feature will be helpful in tracking how much fertilizer is being injected in the soil.
2. Additional environmental parameters such as soil moisture, temperature, and humidity may also be considered for the futures works as those are also a factor in crop growth.
3. Conduct additional inquiries regarding different traditional farming methods used by the farmers. This will be helpful in planning the approach in developing the automated fertigation system.
4. Seek for more professional advises in the field of mechanical, electrical, and agricultural aspect of the project.
5. Upscale the system or the project. This not only covers enlarging the area of the deployment site or the materials and equipment used but as well as the improvement of the existing system itself. This includes:
    a. Increasing the size of the motor to ensure stronger pressure and faster filling of water container.
    b. Using pressurized water tank for higher pressure of water in the irrigation and fertigation process.

c. Increasing the size of pipes used to allow higher flow rate.

6. Include sensors that measure soil moisture, pH levels, and nutrient levels in real-time. The data collected can be used to fully automate the fertigation process and adjustments as needed to maintain optimal growing conditions.
7. Additional features on the mobile application such as displaying the battery energy level, and notification system at mobile application user.
8. Establishment of better means of communication such as Lorawan that provides long-range communication capabilities, allowing devices to communicate over several kilometers in open areas and to be energy-efficient to enable devices to operate on battery power for extended periods.
9. Additional field tests to further validate and enhance the performance of the automated fertigation system.

REFERENCES

[1] C. J. Thirunavuakkarasu, A. Bhaskar, and A. Penujuru, “Automated Fertigation System for Utilization of Fertilizer and Water,” 2017 9th Int. Conf. Inf. Technol. Electr. Eng., pp. 1–6, 2017.

[2] F. Production et al., The future of food and agriculture: trends and challenges, vol. 4, no. 4. 2017. [Online]

[3] J. E. M. Salih, A. H. Adom, and A. Y. M. Shaakaf, “Solar Powered Automated Fertigation Control System for Cucumis Melo L. Cultivation in Green House,” APCBEE Procedia, vol. 4, pp. 79–87, 2012, doi: 10.1016/j.apcbee.2012.11.014.

[4] Building a common vision for sustainable food and agriculture. 2016.

[5] A. Lakhiar, G. Jianmin, T. N. Syed, F. A. Chandio, N. A. Buttar, and W. A. Qureshi, “Monitoring and control systems in agriculture using intelligent sensor techniques: A review of the aeroponic system,” J. Sensors, vol. 2018, 2018, doi: 10.1155/2018/8672769.

[6] S. Muthukumar, M. Naveenraja, V. Naveenkumar, and S. Rajaranganathan, “Sensor Based Automatic Fertigation System.” Available: https://ijsret.com/wp-content/uploads/2019/03/IJSRET_V5_issue2_153.pdf

[7] Swapnali B.Pawar, “IRJET- Smart Irrigation System Using IOT And Raspberry Pi,” 2018.

[8] E. Engineering et al., “AUTOMATED SOLAR POWERED IRRIGATION,” vol. 9, no. 5, pp. 213–223, 2018.

[9] M. G. B. Palconit et al., “IoT-Based Precision Irrigation System for Eggplant and Tomato,” 9th Int. Symp. Comput. Intell. Ind. Appl., no. November, pp. 0–6, 2020.

[10] R. Nandhini, S. Poovizhi, P. Jose, R. Ranjitha, and Dr.S.Anila, “Arduino Based Smart Irrigation System Using IOT,” 3rd Natl. Conf. Intell. Inf. Comput. Technol. IICT ‘17 ARDUINO, no. December, p. 5, 2017.

[11] V. L. Shoba Krishnan, Kalyani Lakkanige, Ragini Ananthakrishnan, Dhaneesh Virwani, “Automated irrigation system,” Agric. Eng., vol. 70, no. 5, pp. 9–11, 2020, doi: 10.17577/ijertv9is060657.

[12] E. Engineering et al., “AUTOMATED SOLAR POWERED IRRIGATION,” vol. 9, no. 5, pp. 213–223, 2018.

[13] U. N. V. P. Rajendranath and V. Berlin Hency, “Implementation of an automated irrigation system: Smart irrigation system (paper subtitle),” Int. J. Appl. Eng. Res., vol. 10, no. 20, pp. 16261–16265, 2015.

[14] O. M. E. Ahmed, A. A. Osman, and S. D. Awadalkarim, “A Design of an Automated Fertigation System Using IoT,” 2018 Int. Conf. Comput. Control. Electr. Electron. Eng. ICCCEEE 2018, pp. 1–5, 2018, doi: 10.1109/ICCCEEE.2018.8515772.

[15] Akshay Y. Kachor, Ketaki Ghodinde, "Design of microcontroller based agribot for fertigation and plantation," 2019 International Conference on Intelligent Computing and Control Systems (ICCS), pp. 1215–1219, 2019.

[16] H. Z. N. Mahyuzie Jenal, “Automated Irrigation and Fertigation System Applying Sensing Technology.” 2021.

[17] K. Kansara, V. Zaveri, S. Shah, S. Delwadkar, and K. Jani, “Sensor based Automated Irrigation System with IOT: A Technical Review,” Int. J. Comput. Sci. Inf. Technol., vol. 6, no. 6, pp. 5331–5333, 2015, [Online].

[18] Q. U. Khand and A. R. Barket, “Smart Water Distribution for Irrigation System Smart Water Distribution for Irrigation System (SWDIS),” Int. J. Innov. Technol. Explor. Eng., vol. 5, no. SEPTEMBER, pp. 0–7, 2015, [Online].

[19] Z. Zhang, C. Chen, H. Li, and H. Xia, “Design, development, and performance evaluation of a fertigation device for distributing solid fertilizer,” Water (Switzerland), vol. 12, no. 9, 2020, doi: 10.3390/W12092621.

[20] Ö. Çetin and E. Akalp, “Efficient Use of Water and Fertilizers in Irrigated Agriculture: Drip Irrigation and Fertigation,” Acta Hortic. Regiotect., vol. 22, no. 2, pp. 97–102, 2019, doi: 10.2478/ahr-2019-0019.

[21] S. Bell, A. B. Koc, J. M. Maja, J. Payero, A. Khalilian, and M. Marshall, “Development of an Automated Linear Move Fertigation System for Cotton Using Active Remote Sensing,” AgriEngineering, vol. 4, no. 1, pp. 320–334, 2022, doi: 10.3390/agriengineering4010022.

[22] M. A. Khairul Zaman, “Design and Implementation of Lab Scale Automated Solar Powered Irrigation and Fertigation System.” 2020.

[23] P. Visconti, R. de Fazio, P. Primiceri, D. Cafagna, S. Strazzella, and N. I. Giannoccaro, “A solar-powered fertigation system based on low-cost wireless sensor network remotely controlled by farmer for irrigation cycles and crops growth

optimization," Int. J. Electron. Telecommun., vol. 66, no. 1, pp. 59–68, 2020, doi: 10.24425/ijet.2019.130266.

[24] M. Anto Bennet, S. Venkatraman, L. Devandra Kumar, E. Anish, and V. X. Abinesh, "Solar Powered Automated Fertigation Control System for Terrace Farming Using Zigbee," Middle-East J. Sci. Res., vol. 24, pp. 401–407, 2016, doi: 10.5829/idosi.mejsr.2016.24.TAET23347.

[25] J. E. M. Salih, A. H. Adom, and A. Y. M. Shaakaf, "Solar Powered Automated Fertigation Control System for Cucumis Melo L. Cultivation in Green House," APCBEE Procedia, vol. 4, pp. 79–87, 2012, doi: 10.1016/j.apcbee.2012.11.014.

[26] U. Ahmad, A. Alvino, and S. Marino, "Solar Fertigation: A Sustainable and Smart IoT-Based Irrigation and Fertilization System for Efficient Water and Nutrient Management," Agronomy, vol. 12, no. 5, 2022, doi: 10.3390/agronomy12051012.

[27] O. Planas, "What Is a Solar Battery? Types and Operation," solar-energy.technology, May 13, 2015. https://solar-energy.technology/photovoltaics/elements/solar-batteries (accessed Jun. 20, 2022).

[28] "Step Down Converter | Step-Down Converter Equations," EEEGUIDE.COM, Mar. 23, 2019. https://www.eeeguide.com/step-down-converter/

[29] "Technical Principles of Valves," https://www.omega.com/en-us/, Apr. 19, 2017. https://www.omega.com/en-us/resources/valves-technical-principles

[30] "Stepper Motors Basics: Types, Uses, and Working Principles," https://www.monolithicpower.com/en/stepper-motors-basics-types-uses

[31] “A Guide to Plumbing Valve Types,” https://www.freshwatersystems.com/blogs/blog/a-guide-to-plumbing-valve-types

[32] “Avnet: Quality Electronic Components & Services,” www.avnet.com. https://www.avnet.com/wps/portal/abacus/solutions/technologies/sensors/pressure-sensors/media-types/water

[33] “Water Flow Sensor - Working Principle , Applications & Examples.,” ElProCus - Electronic Projects for Engineering Students, Aug. 23, 2019. https://www.elprocus.com/a-memoir-on-water-flow-sensor/

[34] “What is PVC Pipe & How is PVC Pipe Manufactured?,” DRTS - Manufacturing Solutions for Drip Irrigation, Pipe Extrusion, and Mining, Feb. 27, 2019. https://drts.com/what-is-pvc-pipe-how-is-it-manufactured/

[35] “Venturi Fertilizer Injectors | IrrigationKing,” www.irrigationking.com. https://www.irrigationking.com/help/irrigation-articles/venturi-fertilizer-injectors/ (accessed Jun. 20, 2022).

[36] “HDPE pipe,” Wikipedia, Nov. 19, 2019. https://en.wikipedia.org/wiki/HDPE_pipe

[37] “Drip Irrigation Emitters,” Drip Depot DIY Irrigation Support. https://help.dripdepot.com/support/solutions/articles/11000044432-all-about-emitters-drippers (accessed Jun. 20, 2022).

[38] “What Is A Microcontrollers: Its Types, Applications, And How Does It Work? - Tesca Technologies Pvt. Ltd.,” Apr. 29, 2021.

https://www.tescaglobal.com/blog/what-is-a-microcontrollers-and-how-does-it-work/

[39] T. Swati and K. R. Rao, "Industrial Process Monitoring System Using ESP32," *International Journal of Recent Technology and Engineering (IJRTE)*, vol. 7, no. 6S4, Apr. 2019.

[40] "What is a Power Relay Module | Relay Modules," GEP Power Products. https://www.geppowerproducts.com/standard-products/power-distribution-fuse-relay-holders-fuse-blocks/relay-modules/

[41] "What is a Single Pole Single Throw (SPST) Switch," www.learningaboutelectronics.com. http://www.learningaboutelectronics.com/Articles/What-is-a-single-pole-single-throw-switch-SPST

[42] "What is a 3-way Solenoid Valve? | Instrumentation Tools," Inst Tools, Jul. 29, 2017. https://instrumentationtools.com/3-way-solenoid-valve/ (accessed Jun. 20, 2022).

[43] "What Are Polyethylene Drums? | Royal Chemical," www.royalchemical.com. https://www.royalchemical.com/blog/polyethylene-drums (accessed Jun. 20, 2022).

[44] J. Benedict, "Ultrasonic Level Sensor - Flowline Liquid & Solid Level Sensors, Switches & Controllers," Flowline Level Sensor, Transmitter, Switch & Control, Oct. 18, 2019. https://www.flowline.com/ultrasonic-level-sensor/ (accessed Jun. 20, 2022).

[45] Wa llStreetMojo, "T-Test," 2022. https://www.wallstreetmojo.com/t-test/

ANNEX I
BILL OF MATERIALS

Item	Price	Quantity	Total Cost
TB6600 Motor Driver	350	1	350.00
DS3231 Real-time Clock	125	1	125.00
Solenoid Valve 1” 12/24 VAC	3400	1	3,400.00
Nema 23 19kg cm	1300	1	1,300.00
GT2 Pulley 6.35mm	150	1	150.00
DF Robot Analog Water Pressure	1300	2	2,600.00
Logic Level Converter Bi-directional	75	2	150.00
MB F. Adapter 1”	40	2	80.00
PVC Ball Valve 1”	100	2	200.00
Teflon	20	2	40.00
Neltex Cement 100cc	100	1	100.00
MB Elbow 1” THD	50	2	100.00
MB Elbow 1”	45	2	90.00
MB Tee 1” THD	60	2	120.00
MB Tee 1”	50	4	200.00
Neltex Blue Pipe 1”	195	2	390.00
G.I. Bushing Reducer	65	2	130.00
Garden Hose	30	3m	90.00
S/S Clamp	20	1	20.00
Drums	2100	2	2,100.00
Solar Panel and Battery	13600	1	13,600.00
Controller	1200	1	1,200.00
Wire	900	1	900.00
Water Motor Pump	3800	1	3,800.00
Male Adaptor	30	3	90.00
Female Adaptor	30	1	30.00
Sandflex Blade	50	1	50.00
Neltex Pipe ¾“	140	2	280.00
MB Elbow ¾”	30	3	90.00
MB Coupling Reducer 1x3/4”	35	3	105.00
Pipe ½	95	2	190.00
MLD Elbow	25	3	75.00
Male Adaptor 1”	45	2	90.00
Reducer 1x½	70	2	140.00
Cord	25	2	50.00
T Pipe	25	3	75.00
Male Adaptor #1	20	3	60.00
Electrical Tape	45	1	45.00
Varnish	45	1	45.00

Sandpaper	15	1	15.00
Brush	35	1	35.00
Cable Clam	55	1	55.00
Relay Module	114	1	114.00
Two-way Solenoid Valve	949	1	949.00
DC-DC Buck Step-Down Converter	58	1	58.00
DC-DC Buck Step-Up Converter	157	1	157.00
2-way Garden Hose	68	1	68.00
Garden Water Connector	53	1	53.00
Drip Irrigation Kit	738	1	738.00
MCD Elbow 1”	45	4	180.00
Coupling Pipe ¾“	25	1	25.00
Speaker Wire	25	2	50.00
Blue PVC Pipe 1”	125	1	125.00
Blue PVC Pipe 3/4”	100	1	100.00
Flat Wire	32	2	64.00
Nail	50	0.5 kg	50.00
Brass Gate Valve	929	1	929.00
Aqualine Elbow ¾”	24.75	1	24.75
Aqualine Male Adapter	32.75	6	196.50
Aqualine Female Adapter	32.75	4	131.00
Aqualine Bushing Reducer	29.75	2	59.50
Foot Valve 1”	451	1	451.00
Venturi Injectors	432	Set (4pcs)	432.00
Chicken Wire	30	10kg	300.00
Linso	480	2	960.00
Angle Bar	310	3	930.00
Other Materials			10000.00
Other Services			10000.00
TOTAL			**50,350.75**

ANNEX II
WRITTEN PROGRAMS

ARDUINO CODES

```
#include <RTClib.h>
#include <WiFi.h>
#include <WiFiUdp.h>
#include <WiFiMulti.h>
#include <NTPClient.h>
#include <HTTPClient.h>
#include <time.h>
#include <TimeLib.h>

WiFiMulti wifiMulti;
WiFiUDP ntpUDP;
NTPClient
timeClient(ntpUDP,
"ph.pool.ntp.org", 28800, 0);

#define echoPin 16 // GPIO
pin Echo of JSN-SR04T
#define trigPin 17 // GPIO pin
Trig of JSN-SR04T
#define flowPin 15 // GPIO
pin Water Flow Sensor

// Define stepper motor
connections and steps per
revolution:
#define dirPin 2
#define stepPin 4
#define stepsPerRevolution
1600

// defines variables
byte pulse1Sec = 0;
int distance_cm = 0; //
variable for the distance
measurement
int pulseCount;
float flowRate, flowLitres,
totalLitres;
float V1, P1, V2, P2; //
variable for pressure voltage
and water pressure
float PDIFF = 0.0;
long duration; // variable for
the duration of sound wave
travel
long currentMillis,
currentMillis2 = 0;
long previousMillis,
previousMillis2 = 0;
String IrrigSchedule, schedd;
String payload_header =
"None";
unsigned int flowMilliLitres;
unsigned int totalMilliLitres;
const int desired_flowrate =
500; // Desired flow rate for
Irrigation/Fertigation Process
const int interval = 1000; // 1
second interval
const int WPSense1 = 36; //
GPIO pin for Water Pressure
Sensor 1
const int WPSense2 = 39; //
GPIO pin for Water Pressure
Sensor 2
const int relay1 = 27; // GPIO
pin for Relay 1
const int relay2 = 14; // GPIO
pin for Relay 2
const int relay3 = 33; // GPIO
pin for Relay 3
const int relay4 = 32; // GPIO
pin for Relay 4
const int relay5 = 5; // GPIO
pin for Relay 5
const int relay6 = 23; // GPIO
pin for Relay 6
const float OffSet = 0.483 ; //
Offset value for the Water
Pressure Sensors
const float calibrationFactor =
4.5; // The hall-effect flow
sensor outputs approximately
4.5 pulses per second per
litre/minute of flow.
const String servername =
"http://waterworks-ai.online";
// Local Server URL
tmElements_t tem;
int tYear, tMonth, tDay,
tHour, tMinute, tSecond;
int flow_status = 0;
int motor_status = 0;

void setup() {
  // put your setup code here, to
run once:
   Serial.begin(115200);
   delay(100);


wifiMulti.addAP(SSID,PASS
WORD);

   while (wifiMulti.run() !=
WL_CONNECTED) {
   delay(500);
   Serial.print(".");
   }

   timeClient.begin();
   delay(100);

   pinMode(relay1,
OUTPUT);
   pinMode(relay2,
OUTPUT);
   pinMode(relay3,
OUTPUT);
   pinMode(relay4,
OUTPUT);
   pinMode(relay5,
OUTPUT);
   pinMode(relay6,
OUTPUT);
   pinMode(trigPin,
OUTPUT); // Sets the trigPin
as an OUTPUT
   pinMode(echoPin,
INPUT); // Sets the echoPin as
an INPUT
   pinMode(flowPin,
INPUT);
   pinMode(WPSense1,
INPUT);
   pinMode(WPSense2,
INPUT);

   digitalWrite(flowPin,
HIGH);

   digitalWrite(relay1, LOW);
   delay(100);
   digitalWrite(relay2, LOW);
   delay(100);
   digitalWrite(relay3,
HIGH);
   delay(100);
   digitalWrite(relay4,
HIGH);
   delay(100);
   digitalWrite(relay5,
HIGH);
   delay(100);
   digitalWrite(relay6,
HIGH);
   delay(100);

   rtc.begin();
   delay(2000);

   if (rtc.lostPower()) {
```

```
    Serial.println("RTC lost power, lets set the time!");
    Rtc_calibrate();
    }

    pulseCount        = 0;
    flowRate          = 0.0;
    flowMilliLitres   = 0;
    totalMilliLitres  = 0;
    previousMillis    = 0;
    previousMillis2    = 0;

    // Configured to trigger on a FALLING state change (transition from HIGH state to LOW state)

attachInterrupt(digitalPinToInterrupt(flowPin), pulseCounter, FALLING);

}


void loop() {
  // put your main code here, to run repeatedly:
  if (Serial.available() > 0) {
    // Read the incoming character
    char input = Serial.read();

    // Process the input using a switch statement
    switch (input) {
      case 'A':

        while (totalMilliLitres < 1000) {
          Flow();
        }
        totalMilliLitres = 0;

        break;
      case 'B':


Serial.println("Working");
        break;
      case 'C':

        while (distance_cm == 0 || distance_cm > 23) {
          WaterLevel();
        }
        distance_cm = 0;

        break;
      case 'D':

        digitalWrite(relay1, LOW);
        delay(100);
        digitalWrite(relay2, LOW);
        delay(100);

        break;
      case 'E':

        digitalWrite(relay1, HIGH);
        delay(100);
        digitalWrite(relay2, HIGH);
        delay(100);

        break;
      case 'F':

        digitalWrite(relay3, LOW);
        delay(100);
        digitalWrite(relay4, LOW);
        delay(100);

        break;
      case 'G':
        digitalWrite(relay3, HIGH);
        delay(100);
        digitalWrite(relay4, HIGH);
        delay(100);

        break;
      case 'H':

        digitalWrite(relay5, LOW);
        delay(100);
        digitalWrite(relay6, LOW);
        delay(100);

        break;
      case 'I':
        digitalWrite(relay5, HIGH);
        delay(100);
        digitalWrite(relay6, HIGH);
        delay(100);

        break;
      case 'P':
        Pressure();

        break;
      case 'W':
        StepUP();

        break;
      case 'S':
        StepDOWN();

        break;
      case 'Q':
        // stop everything
        return;
      default:
        // Handle unrecognized input here
        break;
    }
  }

  if (payload_header == "None") {
    totalMilliLitres = 0;
    http_esp(0,"",0,0,0,0,0);

Serial.println(IrrigSchedule);
  } else {

checkschedule(IrrigSchedule);
  }
  delay(1000);

}

void rtc_calibrate() {
    timeClient.update();


Serial.println(timeClient.getFormattedDate());

Serial.println(timeClient.getFormattedTime());


rtc.adjust(DateTime(timeClient.getEpochTime));
```

```
   delay(1000);

}

void pulseCounter() {
  // Increment the pulse counter
  pulseCount++;
}

void checkschedule(String Schedule) {

  timeClient.update();

  //DateTime now = rtc.now();
  DateTime now = DateTime(timeClient.getEpochTime());
  int yr, mt, day, hr, mins, sec;
  int loc = Schedule.indexOf(" ");
  String sday,hour, minute, second, Fertigation;
  sscanf(Schedule.c_str(), "%d-%d-%d %d:%d:%d", &tYear, &tMonth, &tDay, &tHour, &tMinute, &tSecond);
  tem.Year = CalendarYrToTm(tYear);
  tem.Month = tMonth;
  tem.Day = tDay;
  tem.Hour = tHour;
  tem.Minute = tMinute;
  tem.Second = tSecond;

  time_t sched = makeTime(tem);
  DateTime database = DateTime(sched);
  DateTime endTime = database + TimeSpan(0, 0, 1, 0);

  yr = now.year();
  mt = now.month();
  day = now.day();
  hr = now.hour();
  mins = now.minute();
  sec = now.second();

  if (day < 10) {
   sday = "0" + String(day);
  } else {
   sday = String(day);
          // HTTP header has been send and Server response header has been handled
          Serial.printf("[HTTP] GET... code: %d\n", httpCode);

          // file found at server
          if(httpCode == HTTP_CODE_OK) {
            String payload = http.getString();

Serial.println(payload);
            int loc = payload.indexOf(" ");
            payload_header = payload.substring(0,loc);
            if (payload_header == "IRRIGATION") {
              IrrigSchedule = payload.substring(11,30);
              flow_status = 0;
            } else if (payload_header == "FERTIGATION") {
              IrrigSchedule = payload.substring(12,31);
              flow_status = 1;
            } else if (payload_header == "Unknown Error") {
              payload_header = "None";
            } else {

Serial.println("Packet Sent!");
            }
          }
        } else {
          Serial.printf("[HTTP] GET... failed, error: %s\n", http.errorToString(httpCode).c_str());
        }

        http.end();
    }

    delay(1000);
}

void Pressure() {

  V1 = analogRead(WPSense1) * 5.00 / 4096;  //Sensor1 output voltage
  delay(100);
  V2 = analogRead(WPSense2) * 5.00 / 4096;  //Sensor2 output voltage
  delay(100);
  //Calculate water pressure
  P1 = (V1 - OffSet) * 250;
  P2 = (V2 - OffSet) * 250;

  Serial.print("Voltage1:");
  Serial.print(V1, 3);
  Serial.println("V");

  Serial.print(" Pressure1:");
  Serial.print(P1, 1);
  Serial.println(" KPa");
  Serial.println();

  Serial.print("Voltage2:");
  Serial.print(V2, 3);
  Serial.println("V");

  Serial.print(" Pressure2:");
  Serial.print(P2, 1);
  Serial.println(" KPa");
  Serial.println();

  PDIFF = abs(((P2 - P1)/(P1) * 100));
}

void Flow() {

  currentMillis = millis();
  if (currentMillis - previousMillis > interval) {

    pulse1Sec = pulseCount;
    pulseCount = 0;

    flowRate = ((1000.0 / (millis() - previousMillis)) * pulse1Sec) / calibrationFactor;
    previousMillis = millis();

    flowMilliLitres = (flowRate / 60) * 1000;
    flowLitres = (flowRate / 60);

    totalMilliLitres += flowMilliLitres;
```

```
    totalLitres += flowLitres;

    // Print the flow rate for this second in litres / minute
    Serial.print("Flow rate: ");
    Serial.print(int(flowRate)); // Print the integer part of the variable
    Serial.print("L/min");
    Serial.print("\t");
            // Print tab space

    // Print the cumulative total of litres flowed since starting
    Serial.print("Output Liquid Quantity: ");
    Serial.print(totalMilliLitres);
    Serial.print("mL");
    Serial.print("\t");
            // Print tab space

    Serial.print(totalMilliLitres/1000);
            Serial.println("L");

    Pressure();
  }
}

void WaterLevel() {
  // Clears the trigPin condition
  digitalWrite(trigPin, LOW);
//
  delayMicroseconds(200);
  // Sets the trigPin HIGH (ACTIVE) for 200 microseconds
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(200);
  digitalWrite(trigPin, LOW);
  // Reads the echoPin, returns the sound wave travel time in microseconds
  }

  delay(5000);
}
```

ANDROID STUDIO

Login.java

```
package com.example.waterworksai;

import android.content.Intent;
import android.os.AsyncTask;
import android.os.Bundle;
import android.view.View;
import android.widget.Button;
import android.widget.ImageButton;
import android.widget.TextView;
import android.widget.Toast;

import androidx.appcompat.app.AppCompatActivity;

import com.google.android.material.button.MaterialButton;

import java.io.BufferedInputStream;
import java.io.BufferedReader;
import java.io.IOException;
import java.io.InputStream;
import java.io.InputStreamReader;
import java.net.HttpURLConnection;
import java.net.MalformedURLException;
import java.net.URL;

public class Login extends AppCompatActivity {

    @Override
    protected void onCreate(Bundle savedInstanceState) {

super.onCreate(savedInstanceState);

setContentView(R.layout.login);

        TextView username = (TextView) findViewById(R.id.username);
        TextView password = (TextView) findViewById(R.id.password);
        MaterialButton loginbtn = (MaterialButton) findViewById(R.id.loginbtn);
        Button frgtbtn = (Button) findViewById(R.id.forgotpass);
        ImageButton showhide = (ImageButton) findViewById(R.id.showhide);


loginbtn.setOnClickListener(new View.OnClickListener() {
            @Override
            public void onClick(View view) {
                new HttpGetRequest(username,password).execute();
            }
        });
    }

    private class HttpGetRequest extends AsyncTask<String, String, String> {
        private String link;
        private String result;
```

```
        public
HttpGetRequest(TextView
username, TextView
password) {

            String user =
username.getText().toString()
;
            String pass =
password.getText().toString()
;

            link =
"http://www.waterworks-
ai.online/login.php?username
="+user+"&
password="+pass;
        }

        @Override
        protected String
doInBackground(String...
params) {
            try {
                URL url = new
URL(link);

HttpURLConnection
connection =
(HttpURLConnection)
url.openConnection();

connection.setRequestMetho
d("GET");

                BufferedReader
reader = new
BufferedReader(new
InputStreamReader(connectio
n.getInputStream()));
                StringBuilder
response = new
StringBuilder();
                String line;

                while ((line =
reader.readLine()) != null) {

response.append(line);
                }

                reader.close();

connection.disconnect();
                result =
response.toString();
                return result;
            } catch (IOException
e) {
                e.printStackTrace();

Toast.makeText(Login.this,
"Unknown Error",
Toast.LENGTH_SHORT).sh
ow();
                return null;
            }
        }

        @Override
        protected void
onPostExecute(String result)
{
            if
(result.equals("Success")) {
                //correct

Toast.makeText(Login.this,
"LOGIN SUCCESSFUL",
Toast.LENGTH_SHORT).sh
ow();
                Intent intent = new
Intent(Login.this,
Directory.class);

startActivity(intent);
            } else {
                //incorrect

Toast.makeText(Login.this,
"LOGIN FAILED",
Toast.LENGTH_SHORT).sh
ow();
            }
        }
    }
}
```

Login.xml

```
<?xml version="1.0"
encoding="utf-8"?>
<androidx.constraintlayout.w
idget.ConstraintLayout
xmlns:android="http://schem
as.android.com/apk/res/andro
id"

xmlns:app="http://schemas.a
ndroid.com/apk/res-auto"

xmlns:tools="http://schemas.
android.com/tools"

android:id="@+id/relativeLa
yout3"

android:layout_width="match
_parent"

android:layout_height="matc
h_parent"

android:background="@draw
able/wp"
   tools:context=".Login">


   <TextView

android:id="@+id/signin"

android:layout_width="wrap
_content"

android:layout_height="wrap
_content"

android:layout_marginStart="
10dp"

android:fontFamily="@font/
ubuntub"
      android:text="Sign in"

android:textAlignment="cent
er"

android:textColor="#FFFFFF
"
      android:textSize="35dp"

android:textStyle="bold"
="@id/username" />


<com.google.android.materia
l.button.MaterialButton

android:id="@+id/loginbtn"

android:layout_width="wrap
_content"

android:layout_height="wrap
_content"

android:layout_marginStart="
20dp"

android:layout_marginTop="
10dp"

android:layout_marginEnd="
20dp"

android:layout_marginBotto
m="20dp"

android:backgroundTint="#5
0A5E8"

android:fontFamily="@font/
ubuntub"
      android:text="LOGIN"

app:layout_constraintLeft_to
LeftOf="parent"

app:layout_constraintRight_t
oRightOf="parent"

app:layout_constraintTop_to
BottomOf="@id/password"
/>

   <Button

android:id="@+id/forgotpass
"

android:layout_width="200d
p"

android:layout_height="100d
p"
android:layout_marginStart="
20dp"

android:layout_marginTop="
20dp"

android:layout_marginEnd="
20dp"

android:layout_marginBotto
m="20dp"

android:background="@andr
oid:color/transparent"

android:fontFamily="@font/
ubuntub"
      android:text="Forgot
password?"

android:textColor="@color/
white"

app:layout_constraintBottom
_toBottomOf="parent"

app:layout_constraintLeft_to
LeftOf="parent"

app:layout_constraintRight_t
oRightOf="parent"

app:layout_constraintTop_to
BottomOf="@id/loginbtn"
      tools:visibility="visible"
/>

   <ImageView

android:id="@+id/imageVie
w"

android:layout_width="170d
p"

android:layout_height="276d
p"

android:layout_marginStart="
10dp"

android:layout_marginTop="
24dp"

app:layout_constraintBottom
```

Directory.java

```
package
com.example.waterworksai;

import android.content.Intent;
import android.os.Bundle;
import android.view.View;

import
androidx.appcompat.app.App
CompatActivity;
import
androidx.cardview.widget.Ca
rdView;

public class Directory
extends AppCompatActivity
implements
View.OnClickListener {

   @Override
   protected void
onCreate(Bundle
savedInstanceState) {

super.onCreate(savedInstance
State);

setContentView(R.layout.dire
ctory);

      CardView Schedule =
(CardView)
findViewById(R.id.schedule)
;
      CardView Monitoring =
(CardView)
findViewById(R.id.monitorin
g);
      CardView Upcoming =
(CardView)
findViewById(R.id.upcomin
g);
      CardView History =
(CardView)
findViewById(R.id.previous)
;
      CardView Login =
(CardView)
findViewById(R.id.logout);
      CardView AboutUs =
(CardView)
findViewById(R.id.about);

Schedule.setOnClickListener(
(View.OnClickListener)
this);

Monitoring.setOnClickListen
er((View.OnClickListener)
this);

Upcoming.setOnClickListene
r((View.OnClickListener)
this);

History.setOnClickListener((
View.OnClickListener) this);

Login.setOnClickListener((V
iew.OnClickListener) this);

AboutUs.setOnClickListener(
(View.OnClickListener)
this);

   }

   @Override
   public  void onClick(View
v) {
      Intent i ;
      switch (v.getId()) {
         case R.id.schedule: i =
new
Intent(this,Schedule.class);
startActivity(i); break;
         case R.id.monitoring:
i = new
Intent(this,Monitoring.class);
startActivity(i); break;
         case R.id.upcoming: i
= new
Intent(this,Upcoming.class);
startActivity(i); break;
         case R.id.previous: i =
new
Intent(this,History.class);
startActivity(i); break;
         case R.id.logout: i =
new Intent(this,Login.class);
startActivity(i); break;
         case R.id.about: i =
new
Intent(this,AboutUs.class);
startActivity(i); break;
      }
   }
}
```

Directory.xml

```
<?xml version="1.0"
encoding="utf-8"?>
<androidx.constraintlayout.w
idget.ConstraintLayout
xmlns:android="http://schem
as.android.com/apk/res/andro
id"

xmlns:app="http://schemas.a
ndroid.com/apk/res-auto"

xmlns:tools="http://schemas.
android.com/tools"

android:layout_width="match
_parent"

android:layout_height="matc
h_parent"

tools:context=".Directory">

    <LinearLayout

android:layout_width="match
_parent"

android:layout_height="matc
h_parent"

android:background="@draw
able/wp"

android:orientation="vertical
"

android:weightSum="10"

app:layout_constraintBaselin
e_toBaselineOf="parent">



        <RelativeLayout

android:layout_width="match
_parent"

android:layout_height="0dp"

android:layout_weight="1.25
">

            <TextView
_parent"

android:layout_height="90dp
"

android:layout_gravity="cent
er_horizontal"

android:src="@drawable/ic_s
chedule">

                </ImageView>
                <TextView

android:layout_width="wrap
_content"

android:layout_height="wrap
_content"

android:text="SCHEDULE"

android:textSize="19.5dp"

android:textColor="#5B8BD
F"

android:textAlignment="cent
er"

android:layout_gravity="cent
er_horizontal"

android:fontFamily="@font/
ubuntub">

                </TextView>

            </LinearLayout>


</androidx.cardview.widget.
CardView>


<androidx.cardview.widget.C
ardView

android:id="@+id/monitorin
g"

app:cardBackgroundColor="
@color/white"

android:layout_width="0dp"
android:layout_height="0dp"

android:layout_columnWeigh
t="1"

android:layout_rowWeight="
1"

android:layout_marginBotto
m="15dp"

android:layout_marginLeft="
15dp"

android:layout_marginRight=
"15dp"

app:cardElevation="8dp"

app:cardCornerRadius="8dp"
>

            <LinearLayout

android:layout_width="wrap
_content"

android:layout_height="wrap
_content"

android:layout_gravity="cent
er_horizontal|center_vertical"

android:layout_margin="15d
p"

android:orientation="vertical
">

                <ImageView

android:layout_width="match
_parent"

android:layout_height="90dp
"

android:layout_gravity="cent
er_horizontal"

android:src="@drawable/ic_
monitoring">

                </ImageView>
                <TextView
```

```
android:layout_width="wrap
_content"

android:layout_height="wrap
_content"

android:text="MONITORIN
G"

android:textSize="17.5dp"

android:textColor="#5B8BD
F"

android:textAlignment="cent
er"

android:layout_gravity="cent
er_horizontal"

android:fontFamily="@font/
ubuntub">

            </TextView>

        </LinearLayout>


</androidx.cardview.widget.
CardView>


<androidx.cardview.widget.C
ardView

android:id="@+id/upcoming"

app:cardBackgroundColor="
@color/white"

android:layout_width="0dp"

android:layout_height="0dp"

android:layout_columnWeigh
t="1"

android:layout_rowWeight="
1"

android:layout_marginBotto
m="15dp"

android:layout_marginLeft="
15dp"

android:layout_marginRight=
"15dp"

app:cardElevation="8dp"

app:cardCornerRadius="8dp"
>

            <LinearLayout

android:layout_width="wrap
_content"

android:layout_height="wrap
_content"

android:layout_gravity="cent
er_horizontal|center_vertical"

android:layout_margin="15d
p"

android:orientation="vertical
">

                <ImageView

android:layout_width="match
_parent"

android:layout_height="90dp
"

android:layout_gravity="cent
er_horizontal"

android:src="@drawable/ic_
upcoming">

                </ImageView>
                <TextView

android:layout_width="wrap
_content"

android:layout_height="wrap
_content"

android:text="Upcoming
Activites"

android:textSize="20dp"

android:textColor="#5B8BD
F"

android:textAlignment="cent
er"

android:layout_gravity="cent
er_horizontal"

android:fontFamily="@font/
ubuntub">

            </TextView>

        </LinearLayout>


</androidx.cardview.widget.
CardView>


<androidx.cardview.widget.C
ardView

android:id="@+id/previous"

app:cardBackgroundColor="
@color/white"

android:layout_width="0dp"

android:layout_height="0dp"

android:layout_columnWeigh
t="1"

android:layout_rowWeight="
1"

android:layout_marginBotto
m="15dp"

android:layout_marginLeft="
15dp"

android:layout_marginRight=
"15dp"

app:cardElevation="8dp"

app:cardCornerRadius="8dp"
>

            <LinearLayout

android:layout_width="wrap
_content"
```

```
android:layout_height="wrap
_content"

android:layout_gravity="cent
er_horizontal|center_vertical"

android:layout_margin="15d
p"

android:orientation="vertical
">

            <ImageView

android:layout_width="match
_parent"

android:layout_height="90dp
"

android:layout_gravity="cent
er_horizontal"

android:src="@drawable/ic_
previous">

            </ImageView>
            <TextView

android:layout_width="wrap
_content"

android:layout_height="wrap
_content"

android:text="Previous
Activites"

android:textSize="20dp"

android:textColor="#5B8BD
F"

android:textAlignment="cent
er"

android:layout_gravity="cent
er_horizontal"

android:fontFamily="@font/
ubuntub">

            </TextView>

        </LinearLayout>

</androidx.cardview.widget.
CardView>


<androidx.cardview.widget.C
ardView

android:id="@+id/logout"

app:cardBackgroundColor="
@color/white"

android:layout_width="0dp"

android:layout_height="0dp"

android:layout_columnWeigh
t="1"

android:layout_rowWeight="
1"

android:layout_marginBotto
m="15dp"

android:layout_marginLeft="
15dp"

android:layout_marginRight=
"15dp"

app:cardElevation="8dp"

app:cardCornerRadius="8dp"
>

            <LinearLayout

android:layout_width="wrap
_content"

android:layout_height="wrap
_content"

android:layout_gravity="cent
er_horizontal|center_vertical"

android:layout_margin="15d
p"

android:orientation="vertical
">

                <ImageView

android:layout_width="match
_parent"

android:layout_height="90dp
"

android:layout_gravity="cent
er_horizontal"

android:src="@drawable/ic_l
ogout">

                </ImageView>
                <TextView

android:layout_width="wrap
_content"

android:layout_height="wrap
_content"

android:text="LOGOUT"

android:textSize="20dp"

android:textColor="#5B8BD
F"

android:textAlignment="cent
er"

android:layout_gravity="cent
er_horizontal"

android:fontFamily="@font/
ubuntub">

                </TextView>

            </LinearLayout>


</androidx.cardview.widget.
CardView>


<androidx.cardview.widget.C
ardView

android:id="@+id/about"

app:cardBackgroundColor="
@color/white"

android:layout_width="0dp"
```

```
android:layout_height="0dp"

android:layout_columnWeight="1"

android:layout_rowWeight="1"

android:layout_marginBottom="15dp"

android:layout_marginLeft="15dp"

android:layout_marginRight="15dp"

app:cardElevation="8dp"

app:cardCornerRadius="8dp">

        <LinearLayout

android:layout_width="wrap_content"

android:layout_height="wrap_content"

android:layout_gravity="center_horizontal|center_vertical"

android:layout_margin="15dp"

android:orientation="vertical">

            <ImageView

android:layout_width="match_parent"

android:layout_height="90dp"

android:layout_gravity="center_horizontal"

android:src="@drawable/ic_aboutus">

            </ImageView>
            <TextView

android:layout_width="wrap_content"

android:layout_height="wrap_content"

android:text="ABOUT US"

android:textSize="20dp"

android:textColor="#5B8BDF"

android:textAlignment="center"

android:layout_gravity="center_horizontal"

android:fontFamily="@font/ubuntub">

            </TextView>

        </LinearLayout>


</androidx.cardview.widget.CardView>


    </GridLayout>

  </LinearLayout>

</androidx.constraintlayout.widget.ConstraintLayout>
```

Schedule.java

```
package
com.example.waterworksai;

import android.content.Intent;
import android.os.Bundle;
import android.view.View;

import
androidx.appcompat.app.App
CompatActivity;
import
androidx.cardview.widget.Ca
rdView;

public class Schedule extends
AppCompatActivity
implements
View.OnClickListener {

    private CardView R1,R2;

    @Override
    protected void
onCreate(Bundle
savedInstanceState) {

super.onCreate(savedInstance
State);

setContentView(R.layout.sch
edule);

        R1 = (CardView)
findViewById(R.id.r1);
        R2 = (CardView)
findViewById(R.id.r2);


R1.setOnClickListener((View
.OnClickListener) this);

R2.setOnClickListener((View
.OnClickListener) this);

    }
    @Override
    public  void onClick(View
v) {
        Intent i ;
        switch (v.getId()) {
            case R.id.r1: i = new
Intent(this,Irrigation.class);
startActivity(i); break;
            case R.id.r2: i = new
Intent(this,Fertigation.class);
startActivity(i); break;
        }
    }
}
```

Schedule.xml

```
<?xml version="1.0"
encoding="utf-8"?>
<androidx.constraintlayout.w
idget.ConstraintLayout
xmlns:android="http://schem
as.android.com/apk/res/andro
id"

xmlns:app="http://schemas.a
ndroid.com/apk/res-auto"

xmlns:tools="http://schemas.
android.com/tools"

android:layout_width="match
_parent"

android:layout_height="matc
h_parent"
   tools:context=".Login">

   <LinearLayout

android:layout_width="match
_parent"

android:layout_height="matc
h_parent"

android:background="@draw
able/wp"

android:orientation="vertical
"

android:weightSum="10"

app:layout_constraintBaselin
e_toBaselineOf="parent">



<androidx.constraintlayout.w
idget.ConstraintLayout

android:id="@+id/relativeLa
yout6"

android:layout_width="match
_parent"

android:layout_height="0dp"

android:layout_weight="1.25
">

        <TextView

android:id="@+id/textView"

android:layout_width="wrap
_content"

android:layout_height="wrap
_content"

android:layout_marginStart="
12dp"

android:layout_marginTop="
12dp"

android:layout_marginEnd="
12dp"

android:layout_marginBotto
m="12dp"

android:fontFamily="@font/
ubuntub"

android:text="SCHEDULE
BY"

android:textColor="@color/
white"

android:textSize="50dp"

app:layout_constraintStart_to
StartOf="parent"

app:layout_constraintTop_to
TopOf="parent">

        </TextView>


</androidx.constraintlayout.
widget.ConstraintLayout>

      <GridLayout

android:layout_width="match
_parent"

android:layout_height="0dp"

android:layout_weight="8"

android:alignmentMode="ali
gnMargins"

android:columnCount="2"

android:columnOrderPreserv
ed="false"

android:padding="15dp"

android:rowCount="3">


<androidx.cardview.widget.C
ardView

android:id="@+id/r1"

android:layout_width="0dp"

android:layout_height="0dp"

android:layout_rowWeight="
1"

android:layout_columnWeigh
t="1"

android:layout_marginLeft="
15dp"

android:layout_marginRight=
"15dp"

android:layout_marginBotto
m="15dp"

app:cardBackgroundColor="
@color/white"

app:cardCornerRadius="8dp"

app:cardElevation="8dp">

          <LinearLayout

android:layout_width="wrap
_content"

android:layout_height="wrap
_content"
```

```
android:layout_gravity="cent
er_horizontal|center_vertical"

android:layout_margin="15d
p"

android:orientation="vertical
">

            <ImageView

android:layout_width="match
_parent"

android:layout_height="90dp
"

android:layout_gravity="cent
er_horizontal"

android:src="@drawable/ic_i
rrigation">

            </ImageView>

            <TextView

android:layout_width="wrap
_content"

android:layout_height="wrap
_content"

android:layout_gravity="cent
er_horizontal"

android:fontFamily="@font/
ubuntub"

android:text="IRRIGATION
"

android:textAlignment="cent
er"

android:textColor="#5B8BD
F"

android:textSize="16dp">

            </TextView>

        </LinearLayout>

</androidx.cardview.widget.
CardView>


<androidx.cardview.widget.C
ardView

android:id="@+id/r2"

android:layout_width="0dp"

android:layout_height="0dp"

android:layout_rowWeight="
1"

android:layout_columnWeigh
t="1"

android:layout_marginLeft="
15dp"

android:layout_marginRight=
"15dp"

android:layout_marginBotto
m="15dp"

app:cardBackgroundColor="
@color/white"

app:cardCornerRadius="8dp"

app:cardElevation="8dp">

            <LinearLayout

android:layout_width="wrap
_content"

android:layout_height="wrap
_content"

android:layout_gravity="cent
er_horizontal|center_vertical"

android:layout_margin="15d
p"

android:orientation="vertical
">

                <ImageView

android:layout_width="match
_parent"

android:layout_height="90dp
"

android:layout_gravity="cent
er_horizontal"

android:src="@drawable/ic_f
ertigation">

                </ImageView>

                <TextView

android:layout_width="wrap
_content"

android:layout_height="wrap
_content"

android:layout_gravity="cent
er_horizontal"

android:fontFamily="@font/
ubuntub"

android:text="FERTIGATIO
N"

android:textAlignment="cent
er"

android:textColor="#5B8BD
F"

android:textSize="16dp">

                </TextView>

            </LinearLayout>


</androidx.cardview.widget.
CardView>


        </GridLayout>

    </LinearLayout>

</androidx.constraintlayout.
widget.ConstraintLayout>
```

Irrigation.java

```
package
com.example.waterworksai;

import
android.annotation.SuppressL
int;
import
android.app.DatePickerDialo
g;
import
android.app.TimePickerDialo
g;
import android.content.Intent;
import
android.os.AsyncTask;
import android.os.Bundle;
import android.view.View;
import
android.widget.Button;
import
android.widget.DatePicker;
import
android.widget.EditText;
import
android.widget.ImageButton;
import
android.widget.TextView;
import
android.widget.TimePicker;
import android.widget.Toast;

import
androidx.appcompat.app.App
CompatActivity;

import
java.io.BufferedReader;
import java.io.IOException;
import
java.io.InputStreamReader;
import
java.net.HttpURLConnection
;
import java.net.URL;
import java.util.Calendar;

public class Irrigation extends
AppCompatActivity
implements
      View.OnClickListener {

   Button btnDatePicker,
btnTimePicker;
   TextView txtDate,
txtTime;
   ImageButton btnStrt;
   private int mYear,
mMonth, mDay, mHour,
mMinute;
   private String sMinute;

   @Override
   protected void
onCreate(Bundle
savedInstanceState) {

super.onCreate(savedInstance
State);

setContentView(R.layout.irri
gation);


btnDatePicker=(Button)findV
iewById(R.id.btn_date);

btnTimePicker=(Button)find
ViewById(R.id.btn_time);

btnStrt=(ImageButton)findVi
ewById(R.id.btn_strt);

txtDate=(TextView)findView
ById(R.id.in_date);

txtTime=(TextView)findVie
wById(R.id.in_time);


btnDatePicker.setOnClickList
ener(this);

btnTimePicker.setOnClickLis
tener(this);

btnStrt.setOnClickListener(th
is);

   }

   @Override
   public void onClick(View
v) {

      if (v == btnDatePicker)
{

         // Get Current Date
         final Calendar c =
Calendar.getInstance();
         mYear =
c.get(Calendar.YEAR);
         mMonth =
c.get(Calendar.MONTH);
         mDay =
c.get(Calendar.DAY_OF_M
ONTH);


         DatePickerDialog
datePickerDialog = new
DatePickerDialog(this,
               new
DatePickerDialog.OnDateSet
Listener() {

                  @Override
                  public void
onDateSet(DatePicker view,
int year,

int monthOfYear, int
dayOfMonth) {


txtDate.setText(year + "-" +
(monthOfYear + 1) + "-" +
dayOfMonth);

                  }
               }, mYear,
mMonth, mDay);

datePickerDialog.show();
      }
      if (v == btnTimePicker)
{

         // Get Current Time
         final Calendar c =
Calendar.getInstance();
         mHour =
c.get(Calendar.HOUR_OF_D
AY);
         mMinute =
c.get(Calendar.MINUTE);

         // Launch Time Picker
Dialog
         TimePickerDialog
timePickerDialog = new
TimePickerDialog(this,
```

```
                new
TimePickerDialog.OnTimeSe
tListener() {

                    @Override
                    public void
onTimeSet(TimePicker view,
int hourOfDay,

int minute) {
                        if (minute <
10) {
                            sMinute
= "0" +
String.valueOf(minute);
                        } else {
                            sMinute
= String.valueOf(minute);
                        }

txtTime.setText(hourOfDay
+ ":" + sMinute);
                    }
                }, mHour,
mMinute, false);

timePickerDialog.show();
        }

        if (v == btnStrt){

            // Sends Data
            new
HttpSendIRRIGSchedule(txt
Date,txtTime).execute();
        }
    }

    private class
HttpSendIRRIGSchedule
extends AsyncTask<String,
String, String> {
        private String link;
        private String result;

        public
HttpSendIRRIGSchedule(Te
xtView Date, TextView
Time) {

            String tempdate =
Date.getText().toString();
            String temptime =
Time.getText().toString();
            String datetime =
tempdate + " " + temptime;
            link =
"http://www.waterworks-
ai.online/scheduling.php?valu
e1=IRRIGATION&value2="
+datetime;
        }

        @Override
        protected String
doInBackground(String...
params) {
            try {
                URL url = new
URL(link);

HttpURLConnection
connection =
(HttpURLConnection)
url.openConnection();

connection.setRequestMetho
d("GET");

                BufferedReader
reader = new
BufferedReader(new
InputStreamReader(connectio
n.getInputStream()));
                StringBuilder
response = new
StringBuilder();
                String line;

                while ((line =
reader.readLine()) != null) {

response.append(line);
                }

                reader.close();

connection.disconnect();
                result =
response.toString();
                return result;
            } catch (IOException
e) {
                e.printStackTrace();

Toast.makeText(Irrigation.thi
s, "Unknown Error",
Toast.LENGTH_SHORT).sh
ow();
                return null;
            }
        }

        @Override
        protected void
onPostExecute(String result)
{
            if
(result.equals("Success")) {
                //correct

Toast.makeText(Irrigation.thi
s, "SUCCESSFULLY
SENT",
Toast.LENGTH_SHORT).sh
ow();
            } else {
                //incorrect

Toast.makeText(Irrigation.thi
s, "SCHEDULING
FAILED",
Toast.LENGTH_SHORT).sh
ow();
            }
        }
    }
}
```

Irrigation.xml

```
<?xml version="1.0"
encoding="utf-8"?>
<androidx.constraintlayout.w
idget.ConstraintLayout
xmlns:android="http://schem
as.android.com/apk/res/andro
id"

xmlns:app="http://schemas.a
ndroid.com/apk/res-auto"

xmlns:tools="http://schemas.
android.com/tools"

android:id="@+id/relativeLa
yout5"

android:layout_width="match
_parent"

android:layout_height="matc
h_parent"

android:background="@draw
able/wp">

    <TextView

android:id="@+id/textView"

android:layout_width="wrap
_content"

android:layout_height="wrap
_content"

android:layout_marginStart="
12dp"

android:layout_marginTop="
12dp"

android:layout_marginEnd="
12dp"

android:layout_marginBotto
m="12dp"

android:fontFamily="@font/
ubuntub"

android:text="IRRIGATION
"

android:textColor="@color/
white"
        android:textSize="50dp"

app:layout_constraintStart_to
StartOf="parent"

app:layout_constraintTop_to
TopOf="parent" />

    <TextView

android:id="@+id/in_time"

android:layout_width="214d
p"

android:layout_height="78dp
"

android:layout_marginStart="
10dp"

android:layout_marginLeft="
10dp"

android:layout_marginTop="
5dp"

android:background="@color
/white"
        android:gravity="center"
        android:text="Time"
        android:textSize="25dp"

app:layout_constraintLeft_to
LeftOf="parent"

app:layout_constraintStart_to
StartOf="parent"

app:layout_constraintTop_to
BottomOf="@+id/in_date" />

    <TextView

android:id="@+id/in_date"

android:layout_width="214d
p"

android:layout_height="78dp
"

android:layout_marginStart="
10dp"

android:layout_marginLeft="
10dp"

android:layout_marginTop="
84dp"

android:background="@color
/white"
        android:gravity="center"
        android:text="Date"
        android:textSize="25dp"

app:layout_constraintLeft_to
LeftOf="parent"

app:layout_constraintStart_to
StartOf="parent"

app:layout_constraintTop_to
TopOf="parent" />

    <Button

android:id="@+id/btn_date"

android:layout_width="100d
p"

android:layout_height="wrap
_content"

android:layout_marginStart="
15dp"

android:layout_marginLeft="
10dp"

android:layout_marginBotto
m="17dp"

android:layout_marginRight=
"10dp"
        android:text="SELECT
DATE"

app:layout_constraintBottom
_toBottomOf="@+id/in_date
"

app:layout_constraintLeft_to
RightOf="@+id/in_date"
```

```
app:layout_constraintRight_toRightOf="parent"

app:layout_constraintStart_toEndOf="@+id/in_date" />

    <Button

android:id="@+id/btn_time"

android:layout_width="100dp"

android:layout_height="wrap_content"

android:layout_marginTop="36dp"

android:layout_marginRight="10dp"
        android:text="SELECT TIME"

app:layout_constraintLeft_toLeftOf="@+id/btn_date"

app:layout_constraintRight_toRightOf="parent"

app:layout_constraintStart_toStartOf="@+id/btn_date"

app:layout_constraintTop_toBottomOf="@+id/btn_date" />

    <ImageButton

android:id="@+id/btn_strt"

android:layout_width="wrap_content"

android:layout_height="wrap_content"

android:layout_marginStart="20dp"

android:layout_marginTop="550dp"

android:layout_marginEnd="20dp"

android:layout_marginBottom="20dp"

android:background="@android:color/transparent"

android:importantForAccessibility="no"

android:src="@drawable/ic_play"

app:layout_constraintLeft_toLeftOf="parent"

app:layout_constraintRight_toRightOf="parent"

app:layout_constraintTop_toTopOf="parent" />

    <TextView

android:id="@+id/textView2"

android:layout_width="wrap_content"

android:layout_height="wrap_content"

android:layout_marginTop="500dp"

android:fontFamily="@font/ubuntub"
        android:text=" START"

android:textColor="@color/white"
        android:textSize="25dp"

app:layout_constraintLeft_toLeftOf="parent"

app:layout_constraintRight_toRightOf="parent"

app:layout_constraintTop_toTopOf="parent" />

</androidx.constraintlayout.widget.ConstraintLayout>
```

Fertigation.java

```
package
com.example.waterworksai;

import
android.annotation.SuppressL
int;
import
android.app.DatePickerDialo
g;
import
android.app.TimePickerDialo
g;
import
android.os.AsyncTask;
import android.os.Bundle;
import android.view.View;
import
android.widget.Button;
import
android.widget.DatePicker;
import
android.widget.EditText;
import
android.widget.ImageButton;
import
android.widget.TextView;
import
android.widget.TimePicker;
import android.widget.Toast;

import
androidx.appcompat.app.App
CompatActivity;

import
java.io.BufferedReader;
import java.io.IOException;
import
java.io.InputStreamReader;
import
java.net.HttpURLConnection
;
import java.net.URL;
import java.util.Calendar;

public class Fertigation
extends AppCompatActivity
implements
      View.OnClickListener{

   Button btnDatePicker,
btnTimePicker;
   TextView txtDate,
txtTime;
   ImageButton btnStrt;
   private int mYear,
mMonth, mDay, mHour,
mMinute;
   private String
sMinute,pDate,pTime;

   @Override
   protected void
onCreate(Bundle
savedInstanceState) {

super.onCreate(savedInstance
State);

setContentView(R.layout.fert
igation);


btnDatePicker=(Button)findV
iewById(R.id.btn_date);

btnTimePicker=(Button)find
ViewById(R.id.btn_time);

btnStrt=(ImageButton)findVi
ewById(R.id.btn_strt);

txtDate=(TextView)findView
ById(R.id.in_date);

txtTime=(TextView)findVie
wById(R.id.in_time);


btnDatePicker.setOnClickList
ener(this);

btnTimePicker.setOnClickLis
tener(this);

btnStrt.setOnClickListener(th
is);

   }

   @Override
   public void onClick(View
v) {

      if (v == btnDatePicker)
{

         // Get Current Date
         final Calendar c =
Calendar.getInstance();
         mYear =
c.get(Calendar.YEAR);
         mMonth =
c.get(Calendar.MONTH);
         mDay =
c.get(Calendar.DAY_OF_M
ONTH);


         DatePickerDialog
datePickerDialog = new
DatePickerDialog(this,
               new
DatePickerDialog.OnDateSet
Listener() {

                  @Override
                  public void
onDateSet(DatePicker view,
int year,

int monthOfYear, int
dayOfMonth) {


txtDate.setText(year + "-" +
(monthOfYear + 1) + "-" +
dayOfMonth);

                  }
               }, mYear,
mMonth, mDay);

datePickerDialog.show();
      }
      if (v == btnTimePicker)
{

         // Get Current Time
         final Calendar c =
Calendar.getInstance();
         mHour =
c.get(Calendar.HOUR_OF_D
AY);
         mMinute =
c.get(Calendar.MINUTE);

         // Launch Time Picker
Dialog
         TimePickerDialog
timePickerDialog = new
TimePickerDialog(this,
               new
TimePickerDialog.OnTimeSe
tListener() {
```

Fertigation.xml

```
<?xml version="1.0"
encoding="utf-8"?>
<androidx.constraintlayout.w
idget.ConstraintLayout
xmlns:android="http://schem
as.android.com/apk/res/andro
id"

xmlns:app="http://schemas.a
ndroid.com/apk/res-auto"

xmlns:tools="http://schemas.
android.com/tools"

android:id="@+id/relativeLa
yout4"

android:layout_width="match
_parent"

android:layout_height="matc
h_parent"

android:background="@draw
able/wp">

    <TextView

android:id="@+id/textView"

android:layout_width="wrap
_content"

android:layout_height="wrap
_content"

android:layout_marginStart="
12dp"

android:layout_marginTop="
12dp"

android:layout_marginEnd="
12dp"

android:layout_marginBotto
m="12dp"

android:fontFamily="@font/
ubuntub"

android:text="FERTIGATIO
N"

android:textColor="@color/
white"
        android:textSize="50dp"

app:layout_constraintStart_to
StartOf="parent"

app:layout_constraintTop_to
TopOf="parent" />

    <TextView

android:id="@+id/in_time"

android:layout_width="214d
p"

android:layout_height="78dp
"

android:layout_marginStart="
10dp"

android:layout_marginLeft="
10dp"

android:layout_marginTop="
5dp"

android:background="@color
/white"
        android:gravity="center"
        android:text="Time"
        android:textSize="25dp"

app:layout_constraintLeft_to
LeftOf="parent"

app:layout_constraintStart_to
StartOf="parent"

app:layout_constraintTop_to
BottomOf="@+id/in_date" />

    <TextView

android:id="@+id/in_date"

android:layout_width="214d
p"

android:layout_height="78dp
"

android:layout_marginStart="
10dp"

android:layout_marginLeft="
10dp"

android:layout_marginTop="
84dp"

android:background="@color
/white"
        android:gravity="center"
        android:text="Date"
        android:textSize="25dp"

app:layout_constraintLeft_to
LeftOf="parent"

app:layout_constraintStart_to
StartOf="parent"

app:layout_constraintTop_to
TopOf="parent" />

    <Button

android:id="@+id/btn_date"

android:layout_width="100d
p"

android:layout_height="wrap
_content"

android:layout_marginStart="
15dp"

android:layout_marginRight=
"10dp"

android:layout_marginBotto
m="12dp"
        android:text="SELECT
DATE"

app:layout_constraintBottom
_toBottomOf="@+id/in_date
"

app:layout_constraintLeft_to
RightOf="@+id/in_date"

app:layout_constraintRight_t
oRightOf="parent"
```

```
app:layout_constraintStart_to
EndOf="@+id/in_date" />

   <Button

android:id="@+id/btn_time"

android:layout_width="100d
p"

android:layout_height="wrap
_content"

android:layout_marginTop="
36dp"

android:layout_marginRight=
"10dp"
      android:text="SELECT
TIME"

app:layout_constraintLeft_to
LeftOf="@+id/btn_date"

app:layout_constraintStart_to
StartOf="@+id/btn_date"

app:layout_constraintRight_t
oRightOf="parent"

app:layout_constraintTop_to
BottomOf="@+id/btn_date"
/>

   <ImageButton

android:id="@+id/btn_strt"

android:layout_width="wrap
_content"

android:layout_height="wrap
_content"

android:layout_marginStart="
20dp"

android:layout_marginTop="
550dp"

android:layout_marginEnd="
20dp"

android:layout_marginBotto
m="20dp"

android:background="@andr
oid:color/transparent"

android:importantForAccessi
bility="no"

android:src="@drawable/ic_
play"

app:layout_constraintLeft_to
LeftOf="parent"

app:layout_constraintRight_t
oRightOf="parent"

app:layout_constraintTop_to
TopOf="parent" />

   <TextView

android:id="@+id/textView2
"

android:layout_width="wrap
_content"

android:layout_height="wrap
_content"

android:layout_marginTop="
500dp"

android:fontFamily="@font/
ubuntub"
      android:text=" START"

android:textColor="@color/
white"
      android:textSize="25dp"

app:layout_constraintLeft_to
LeftOf="parent"

app:layout_constraintRight_t
oRightOf="parent"

app:layout_constraintTop_to
TopOf="parent" />

</androidx.constraintlayout.
widget.ConstraintLayout>
```

Monitoring.java

```
package
com.example.waterworksai;

import
android.annotation.SuppressL
int;
import
android.os.AsyncTask;
import android.os.Bundle;
import android.os.Handler;
import android.view.View;
import
android.widget.Button;
import
android.widget.TextView;
import android.widget.Toast;

import
androidx.appcompat.app.App
CompatActivity;

import
java.io.BufferedReader;
import java.io.IOException;
import
java.io.InputStreamReader;
import
java.net.HttpURLConnection
;
import java.net.URL;

public class Monitoring
extends AppCompatActivity
{

   private TextView
waterflow, waterpressure,
waterlevel, status;

   private Handler handler;

   @Override
   protected void
onCreate(Bundle
savedInstanceState) {

super.onCreate(savedInstance
State);

setContentView(R.layout.mo
nitoring);

      waterflow = (TextView)
findViewById(R.id.waterflo
w);
      waterpressure =
(TextView)
findViewById(R.id.waterpres
sure);
      waterlevel = (TextView)
findViewById(R.id.waterleve
l);
      status = (TextView)
findViewById(R.id.waterstat
us);

      new
Monitoring.HttpMonitoring()
.execute();

      // Create a new handler
      handler = new
Handler();

      // Call the refresh
method after 5 seconds

handler.postDelayed(refreshR
unnable, 5000);
   }

   private class
HttpMonitoring extends
AsyncTask<String, String,
String> {
      private String link;
      private String result;

      public HttpMonitoring()
{
         link =
"http://www.waterworks-
ai.online/monitoring.php";
      }

      @Override
      protected String
doInBackground(String...
params) {
         try {
            URL url = new
URL(link);

HttpURLConnection
connection =
(HttpURLConnection)
url.openConnection();

connection.setRequestMetho
d("GET");

            BufferedReader
reader = new
BufferedReader(new
InputStreamReader(connectio
n.getInputStream()));
            StringBuilder
response = new
StringBuilder();
            String line;

            while ((line =
reader.readLine()) != null) {

response.append(line);
            }

            reader.close();

connection.disconnect();
            result =
response.toString();
            return result;
         } catch (IOException
e) {
            e.printStackTrace();

Toast.makeText(Monitoring.t
his, "Unknown Error",
Toast.LENGTH_SHORT).sh
ow();
            return null;
         }
      }

      @Override
      protected void
onPostExecute(String result)
{

         try {
            String[] elements =
result.split(" ");


waterflow.setText(elements[1
]);

waterpressure.setText(elemen
ts[2]);

waterlevel.setText(elements[
0]);
```

```
status.setText(elements[3]);

            } catch (Exception e)
{
                e.printStackTrace();

Toast.makeText(Monitoring.t
his, "Unknown Error",
Toast.LENGTH_SHORT).sh
ow();
            }
        }
    }

    // Define a Runnable to
refresh the activity
    private Runnable
refreshRunnable = new
Runnable() {
        @Override
        public void run() {
            // Restart the activity
            recreate();

            // Call the refresh
method again after 5 seconds

handler.postDelayed(this,
5000);
        }
    };

    @Override
    protected void onDestroy()
{
        super.onDestroy();

        // Remove the handler
callbacks when the activity is
destroyed

handler.removeCallbacks(refr
eshRunnable);
    }
}
```

Monitoring.xml

```
<?xml version="1.0"
encoding="utf-8"?>
<androidx.constraintlayout.w
idget.ConstraintLayout
xmlns:android="http://schem
as.android.com/apk/res/andro
id"

xmlns:app="http://schemas.a
ndroid.com/apk/res-auto"

xmlns:tools="http://schemas.
android.com/tools"

android:id="@+id/relativeLa
yout"

android:layout_width="match
_parent"

android:layout_height="matc
h_parent"

android:background="@draw
able/wp"
   tools:context=".Login">

   <TextView

android:id="@+id/textView"

android:layout_width="wrap
_content"

android:layout_height="wrap
_content"

android:layout_marginStart="
12dp"

android:layout_marginLeft="
12dp"

android:layout_marginTop="
12dp"

android:layout_marginRight=
"12dp"

android:fontFamily="@font/
ubuntub"

android:text="ONGOING
ACTIVITIES"

android:textColor="@color/
white"
      android:textSize="32dp"

app:layout_constraintStart_to
StartOf="parent"

app:layout_constraintTop_to
TopOf="parent" />

   <TableLayout

android:id="@+id/tableLayo
ut"

android:layout_width="0dp"

android:layout_height="wrap
_content"

android:layout_marginStart="
4dp"

android:layout_marginLeft="
4dp"

android:layout_marginTop="
135dp"

android:layout_marginEnd="
4dp"

android:layout_marginRight=
"4dp"

android:layout_marginBotto
m="142dp"

android:background="@draw
able/table_border"

android:shrinkColumns="*"

android:stretchColumns="*"

app:layout_constraintBottom
_toBottomOf="@+id/textVie
w2"

app:layout_constraintEnd_to
EndOf="parent"

app:layout_constraintStart_to
StartOf="parent"

app:layout_constraintTop_to
TopOf="parent">

      <TableRow>

         <TextView

android:background="@draw
able/table_border"

android:padding="10dp"

android:text="WATER
FLOW RATE"

android:textAlignment="cent
er"

android:textStyle="bold" />

         <TextView

android:background="@draw
able/table_border"

android:padding="10dp"

android:text="WATER
PRESSURE"

android:textAlignment="cent
er"

android:textStyle="bold" />

         <TextView

android:background="@draw
able/table_border"

android:padding="10dp"

android:text="STATUS"

android:textAlignment="cent
er"

android:textStyle="bold" />
      </TableRow>

      <TableRow>

         <TextView
```

```
android:id="@+id/waterflow
"

android:background="@draw
able/table_border"

android:padding="10dp"
            android:text=""

android:textAlignment="cent
er" />

        <TextView

android:id="@+id/waterpress
ure"

android:background="@draw
able/table_border"

android:padding="10dp"
            android:text=""

android:textAlignment="cent
er" />

        <TextView

android:id="@+id/waterstatu
s"

android:background="@draw
able/table_border"

android:padding="10dp"
            android:text=""

android:textAlignment="cent
er" />
      </TableRow>

   </TableLayout>

   <TextView

android:id="@+id/textView2
"

android:layout_width="wrap
_content"

android:layout_height="wrap
_content"

android:layout_marginStart="
12dp"

android:layout_marginLeft="
12dp"

android:layout_marginTop="
315dp"

android:fontFamily="@font/
ubuntub"
      android:text="WATER
LEVEL"

android:textColor="@color/
white"
      android:textSize="34dp"

app:layout_constraintStart_to
StartOf="parent"

app:layout_constraintTop_to
TopOf="parent" />


   <EditText

android:id="@+id/Tank"

android:layout_width="wrap
_content"

android:layout_height="wrap
_content"

android:layout_marginStart="
12dp"

android:layout_marginLeft="
12dp"

android:layout_marginTop="
45dp"

android:fontFamily="@font/
ubuntub"
      android:text="Tank
Level"

android:textColor="@color/
white"
      android:textSize="25dp"

app:layout_constraintStart_to
StartOf="parent"

app:layout_constraintTop_to
BottomOf="@+id/textView2
" />

   <TextView

android:id="@+id/waterlevel
"

android:layout_width="wrap
_content"

android:layout_height="wrap
_content"

android:layout_marginTop="
24dp"

android:fontFamily="@font/
ubuntub"
      android:text=""

android:textColor="@color/
white"
      android:textSize="25dp"

app:layout_constraintEnd_to
EndOf="parent"

app:layout_constraintStart_to
StartOf="parent"

app:layout_constraintTop_to
BottomOf="@+id/Tank" />

</androidx.constraintlayout.
widget.ConstraintLayout>
```

History.java

```
package
com.example.waterworksai;

import
android.annotation.SuppressL
int;
import android.content.Intent;
import
android.os.AsyncTask;
import android.os.Bundle;
import android.os.Handler;
import android.view.View;
import
android.widget.Button;
import
android.widget.TextView;
import android.widget.Toast;

import
androidx.appcompat.app.App
CompatActivity;

import
java.io.BufferedReader;
import java.io.IOException;
import
java.io.InputStreamReader;
import
java.net.HttpURLConnection
;
import java.net.URL;

public class History extends
AppCompatActivity {

    private          TextView
table_11,table_12,table_13,ta
ble_14,table_21,table_22,tabl
e_23,table_24,

table_31,table_32,table_33,ta
ble_34,table_41,table_42,tabl
e_43,table_44,

table_51,table_52,table_53,ta
ble_54,table_61,table_62,tabl
e_63,table_64,

table_71,table_72,table_73,ta
ble_74,table_81,table_82,tabl
e_83,table_84,

table_91,table_92,table_93,ta
ble_94,table_101,table_102,t
able_103,table_104;


    @Override
    protected void
onCreate(Bundle
savedInstanceState) {

super.onCreate(savedInstance
State);

setContentView(R.layout.hist
ory);

        table_11 = (TextView)
findViewById(R.id.Table11);
        table_12 = (TextView)
findViewById(R.id.Table12);
        table_13 = (TextView)
findViewById(R.id.Table13);
        table_14 = (TextView)
findViewById(R.id.Table14);

        table_21 = (TextView)
findViewById(R.id.Table21);
        table_22 = (TextView)
findViewById(R.id.Table22);
        table_23 = (TextView)
findViewById(R.id.Table23);
        table_24 = (TextView)
findViewById(R.id.Table24);

        table_31 = (TextView)
findViewById(R.id.Table31);
        table_32 = (TextView)
findViewById(R.id.Table32);
        table_33 = (TextView)
findViewById(R.id.Table33);
        table_34 = (TextView)
findViewById(R.id.Table34);

        table_41 = (TextView)
findViewById(R.id.Table41);
        table_42 = (TextView)
findViewById(R.id.Table42);
        table_43 = (TextView)
findViewById(R.id.Table43);
        table_44 = (TextView)
findViewById(R.id.Table44);

        table_51 = (TextView)
findViewById(R.id.Table51);
        table_52 = (TextView)
findViewById(R.id.Table52);
        table_53 = (TextView)
findViewById(R.id.Table53);
        table_54 = (TextView)
findViewById(R.id.Table54);

        table_61 = (TextView)
findViewById(R.id.Table61);
        table_62 = (TextView)
findViewById(R.id.Table62);
        table_63 = (TextView)
findViewById(R.id.Table63);
        table_64 = (TextView)
findViewById(R.id.Table64);

        table_71 = (TextView)
findViewById(R.id.Table71);
        table_72 = (TextView)
findViewById(R.id.Table72);
        table_73 = (TextView)
findViewById(R.id.Table73);
        table_74 = (TextView)
findViewById(R.id.Table74);

        table_81 = (TextView)
findViewById(R.id.Table81);
        table_82 = (TextView)
findViewById(R.id.Table82);
        table_83 = (TextView)
findViewById(R.id.Table83);
        table_84 = (TextView)
findViewById(R.id.Table84);

        table_91 = (TextView)
findViewById(R.id.Table91);
        table_92 = (TextView)
findViewById(R.id.Table92);
        table_93 = (TextView)
findViewById(R.id.Table93);
        table_94 = (TextView)
findViewById(R.id.Table94);

        table_101 = (TextView)
findViewById(R.id.Table101
);
        table_102 = (TextView)
findViewById(R.id.Table102
);
        table_103 = (TextView)
findViewById(R.id.Table103
);
        table_104 = (TextView)
findViewById(R.id.Table104
);
```

```
        new
History.HttpGetHistory().exe
cute();
    }

    private class
HttpGetHistory extends
AsyncTask<String, String,
String> {
        private String link;
        private String result;

        public HttpGetHistory()
{
            link =
"http://www.waterworks-
ai.online/check-history.php";
        }

        @Override
        protected String
doInBackground(String...
params) {
            try {
                URL url = new
URL(link);

HttpURLConnection
connection =
(HttpURLConnection)
url.openConnection();

connection.setRequestMetho
d("GET");

                BufferedReader
reader = new
BufferedReader(new
InputStreamReader(connectio
n.getInputStream()));
                StringBuilder
response = new
StringBuilder();
                String line;

                while ((line =
reader.readLine()) != null) {

response.append(line);
                }

                reader.close();

connection.disconnect();
                result =
response.toString();
                return result;
            } catch (IOException
e) {
                e.printStackTrace();

Toast.makeText(History.this,
"Unknown Error",
Toast.LENGTH_SHORT).sh
ow();
                return null;
            }
        }

        @Override
        protected void
onPostExecute(String result)
{

            try {

                String[] elements =
result.split("<br>");
                String[]
table_elements = new
String[40];

                String connector =
elements[0];

                for (int i = 1; i <
elements.length; i++) {
                    connector =
connector + " " + elements[i];
                }

                table_elements =
connector.split(" ");


table_11.setText(table_eleme
nts[0]);

table_12.setText(table_eleme
nts[1]);

table_13.setText(table_eleme
nts[2]);

table_14.setText(table_eleme
nts[3]);


table_21.setText(table_eleme
nts[4]);

table_22.setText(table_eleme
nts[5]);

table_23.setText(table_eleme
nts[6]);

table_24.setText(table_eleme
nts[7]);


table_31.setText(table_eleme
nts[8]);

table_32.setText(table_eleme
nts[9]);

table_33.setText(table_eleme
nts[10]);

table_34.setText(table_eleme
nts[11]);


table_41.setText(table_eleme
nts[12]);

table_42.setText(table_eleme
nts[13]);

table_43.setText(table_eleme
nts[14]);

table_44.setText(table_eleme
nts[15]);


table_51.setText(table_eleme
nts[16]);

table_52.setText(table_eleme
nts[17]);

table_53.setText(table_eleme
nts[18]);

table_54.setText(table_eleme
nts[19]);


table_61.setText(table_eleme
nts[20]);

table_62.setText(table_eleme
nts[21]);
```

```
table_63.setText(table_elements[22]);

table_64.setText(table_elements[23]);


table_71.setText(table_elements[24]);

table_72.setText(table_elements[25]);

table_73.setText(table_elements[26]);

table_74.setText(table_elements[27]);


table_81.setText(table_elements[28]);

table_82.setText(table_elements[29]);

table_83.setText(table_elements[30]);

table_84.setText(table_elements[31]);


table_91.setText(table_elements[32]);

table_92.setText(table_elements[33]);

table_93.setText(table_elements[34]);

table_94.setText(table_elements[35]);


table_101.setText(table_elements[36]);

table_102.setText(table_elements[37]);

table_103.setText(table_elements[38]);

table_104.setText(table_elements[39]);

        } catch (Exception e)
{
            e.printStackTrace();

Toast.makeText(History.this,
"Unknown Error",
Toast.LENGTH_SHORT).show();
        }
      }
   }

}
```

History.xml

```
<?xml version="1.0"
encoding="utf-8"?>
<androidx.constraintlayout.w
idget.ConstraintLayout
xmlns:android="http://schem
as.android.com/apk/res/andro
id"

xmlns:app="http://schemas.a
ndroid.com/apk/res-auto"

xmlns:tools="http://schemas.
android.com/tools"

android:id="@+id/relativeLa
yout8"

android:layout_width="match
_parent"

android:layout_height="matc
h_parent"

android:background="@draw
able/wp"
   tools:context=".Login">

   <TextView

android:id="@+id/textView3
"

android:layout_width="wrap
_content"

android:layout_height="wrap
_content"

android:layout_marginStart="
12dp"

android:layout_marginLeft="
12dp"

android:layout_marginTop="
12dp"

android:fontFamily="@font/
ubuntub"

android:text="PREVIOUS
ACTIVITIES"

android:textColor="@color/
white"
      android:textSize="34dp"

app:layout_constraintStart_to
StartOf="parent"

app:layout_constraintTop_to
TopOf="parent" />

   <TableLayout

android:id="@+id/tableLayo
ut"

android:layout_width="0dp"

android:layout_height="wrap
_content"

android:layout_marginTop="
135dp"

android:background="@draw
able/table_border"

android:shrinkColumns="*"

android:stretchColumns="*"

app:layout_constraintEnd_to
EndOf="parent"

app:layout_constraintStart_to
StartOf="parent"

app:layout_constraintTop_to
TopOf="parent">

      <TableRow>

         <TextView

android:background="@draw
able/table_border"

android:padding="10dp"

android:text="METHOD"

android:textStyle="bold" />

         <TextView

android:background="@draw
able/table_border"

android:padding="10dp"

android:text="DATE"

android:textStyle="bold" />

         <TextView

android:background="@draw
able/table_border"

android:padding="10dp"

android:text="TIME"

android:textStyle="bold" />

         <TextView

android:background="@draw
able/table_border"

android:padding="10dp"

android:text="REMARKS"

android:textStyle="bold" />
      </TableRow>

      <TableRow>

         <TextView

android:id="@+id/Table11"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

         <TextView

android:id="@+id/Table12"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

         <TextView
```

```
android:id="@+id/Table13"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/Table14"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />
    </TableRow>

    <TableRow>

        <TextView

android:id="@+id/Table21"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/Table22"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/Table23"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/Table24"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />
    </TableRow>

    <TableRow>

        <TextView

android:id="@+id/Table31"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/Table32"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/Table33"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/Table34"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />
    </TableRow>

    <TableRow>

        <TextView

android:id="@+id/Table41"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/Table42"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/Table43"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/Table44"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />
    </TableRow>

    <TableRow>

        <TextView

android:id="@+id/Table51"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/Table52"

android:background="@draw
able/table_border"
```

```
android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/Table53"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/Table54"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />
    </TableRow>

    <TableRow>

        <TextView

android:id="@+id/Table61"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/Table62"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/Table63"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/Table64"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />
    </TableRow>

    <TableRow>

        <TextView

android:id="@+id/Table71"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/Table72"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/Table73"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/Table74"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />
    </TableRow>

    <TableRow>

        <TextView

android:id="@+id/Table81"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/Table82"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/Table83"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/Table84"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />
    </TableRow>

    <TableRow>

        <TextView

android:id="@+id/Table91"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView
```

```
android:id="@+id/Table92"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/Table93"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/Table94"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />
    </TableRow>

    <TableRow>

        <TextView

android:id="@+id/Table101"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/Table102"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/Table103"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/Table104"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />
    </TableRow>

</TableLayout>
</androidx.constraintlayout.
widget.ConstraintLayout>
```

Upcoming.java

```
package
com.example.waterworksai;

import
android.annotation.SuppressL
int;
import
android.os.AsyncTask;
import android.os.Bundle;
import android.view.View;
import
android.widget.Button;
import
android.widget.TextView;
import android.widget.Toast;

import
androidx.appcompat.app.App
CompatActivity;

import
java.io.BufferedReader;
import java.io.IOException;
import
java.io.InputStreamReader;
import
java.net.HttpURLConnection
;
import java.net.URL;

public class Upcoming
extends AppCompatActivity
{

    private          TextView
table_11,table_12,table_13,ta
ble_14,table_21,table_22,tabl
e_23,table_24,

table_31,table_32,table_33,ta
ble_34,table_41,table_42,tabl
e_43,table_44,

table_51,table_52,table_53,ta
ble_54,table_61,table_62,tabl
e_63,table_64,

table_71,table_72,table_73,ta
ble_74,table_81,table_82,tabl
e_83,table_84,

table_91,table_92,table_93,ta
ble_94,table_101,table_102,t
able_103,table_104;

    @Override
    protected void
onCreate(Bundle
savedInstanceState) {

super.onCreate(savedInstance
State);

setContentView(R.layout.upc
oming);

        table_11 = (TextView)
findViewById(R.id.table11);
        table_12 = (TextView)
findViewById(R.id.table12);
        table_13 = (TextView)
findViewById(R.id.table13);
        table_14 = (TextView)
findViewById(R.id.table14);

        table_21 = (TextView)
findViewById(R.id.table21);
        table_22 = (TextView)
findViewById(R.id.table22);
        table_23 = (TextView)
findViewById(R.id.table23);
        table_24 = (TextView)
findViewById(R.id.table24);

        table_31 = (TextView)
findViewById(R.id.table31);
        table_32 = (TextView)
findViewById(R.id.table32);
        table_33 = (TextView)
findViewById(R.id.table33);
        table_34 = (TextView)
findViewById(R.id.table34);

        table_41 = (TextView)
findViewById(R.id.table41);
        table_42 = (TextView)
findViewById(R.id.table42);
        table_43 = (TextView)
findViewById(R.id.table43);
        table_44 = (TextView)
findViewById(R.id.table44);

        table_51 = (TextView)
findViewById(R.id.table51);
        table_52 = (TextView)
findViewById(R.id.table52);
        table_53 = (TextView)
findViewById(R.id.table53);
        table_54 = (TextView)
findViewById(R.id.table54);

        table_61 = (TextView)
findViewById(R.id.table61);
        table_62 = (TextView)
findViewById(R.id.table62);
        table_63 = (TextView)
findViewById(R.id.table63);
        table_64 = (TextView)
findViewById(R.id.table64);

        table_71 = (TextView)
findViewById(R.id.table71);
        table_72 = (TextView)
findViewById(R.id.table72);
        table_73 = (TextView)
findViewById(R.id.table73);
        table_74 = (TextView)
findViewById(R.id.table74);

        table_81 = (TextView)
findViewById(R.id.table81);
        table_82 = (TextView)
findViewById(R.id.table82);
        table_83 = (TextView)
findViewById(R.id.table83);
        table_84 = (TextView)
findViewById(R.id.table84);

        table_91 = (TextView)
findViewById(R.id.table91);
        table_92 = (TextView)
findViewById(R.id.table92);
        table_93 = (TextView)
findViewById(R.id.table93);
        table_94 = (TextView)
findViewById(R.id.table94);

        table_101 = (TextView)
findViewById(R.id.table101)
;
        table_102 = (TextView)
findViewById(R.id.table102)
;
        table_103 = (TextView)
findViewById(R.id.table103)
;
        table_104 = (TextView)
findViewById(R.id.table104)
;

        new
Upcoming.HttpGetUpcoming
().execute();
    }
```

```
   private class
HttpGetUpcoming extends
AsyncTask<String, String,
String> {
      private String link;
      private String result;

      public
HttpGetUpcoming() {
         link =
"http://www.waterworks-
ai.online/check-
schedules.php";
      }

      @Override
      protected String
doInBackground(String...
params) {
         try {
            URL url = new
URL(link);

HttpURLConnection
connection =
(HttpURLConnection)
url.openConnection();

connection.setRequestMetho
d("GET");

            BufferedReader
reader = new
BufferedReader(new
InputStreamReader(connectio
n.getInputStream()));
            StringBuilder
response = new
StringBuilder();
            String line;

            while ((line =
reader.readLine()) != null) {

response.append(line);
            }

            reader.close();

connection.disconnect();
            result =
response.toString();
            return result;
         } catch (IOException
e) {
            e.printStackTrace();

Toast.makeText(Upcoming.t
his, "Unknown Error",
Toast.LENGTH_SHORT).sh
ow();
            return null;
         }
      }

      @Override
      protected void
onPostExecute(String result)
{

         try {

            String[] elements =
result.split("<br>");
            String[]
table_elements = new
String[40];

            String connector =
elements[0];

            for (int i = 1; i <
elements.length; i++) {
               connector =
connector + " " + elements[i];
            }

            table_elements =
connector.split(" ");


table_11.setText(table_eleme
nts[0]);

table_12.setText(table_eleme
nts[1]);

table_13.setText(table_eleme
nts[2]);

table_14.setText(table_eleme
nts[3]);


table_21.setText(table_eleme
nts[4]);

table_22.setText(table_eleme
nts[5]);

table_23.setText(table_eleme
nts[6]);

table_24.setText(table_eleme
nts[7]);


table_31.setText(table_eleme
nts[8]);

table_32.setText(table_eleme
nts[9]);

table_33.setText(table_eleme
nts[10]);

table_34.setText(table_eleme
nts[11]);


table_41.setText(table_eleme
nts[12]);

table_42.setText(table_eleme
nts[13]);

table_43.setText(table_eleme
nts[14]);

table_44.setText(table_eleme
nts[15]);


table_51.setText(table_eleme
nts[16]);

table_52.setText(table_eleme
nts[17]);

table_53.setText(table_eleme
nts[18]);

table_54.setText(table_eleme
nts[19]);


table_61.setText(table_eleme
nts[20]);

table_62.setText(table_eleme
nts[21]);

table_63.setText(table_eleme
nts[22]);
```

Upcoming.xml

```
<?xml version="1.0"
encoding="utf-8"?>
<androidx.constraintlayout.w
idget.ConstraintLayout
xmlns:android="http://schem
as.android.com/apk/res/andro
id"

xmlns:app="http://schemas.a
ndroid.com/apk/res-auto"

xmlns:tools="http://schemas.
android.com/tools"

android:id="@+id/relativeLa
yout7"

android:layout_width="match
_parent"

android:layout_height="matc
h_parent"

android:background="@draw
able/wp"
   tools:context=".Login">

   <TextView

android:id="@+id/textView3
"

android:layout_width="wrap
_content"

android:layout_height="wrap
_content"

android:layout_marginStart="
12dp"

android:layout_marginLeft="
12dp"

android:layout_marginTop="
12dp"

android:fontFamily="@font/
ubuntub"

android:text="UPCOMING
ACTIVITIES"

android:textColor="@color/
white"
      android:textSize="34dp"

app:layout_constraintStart_to
StartOf="parent"

app:layout_constraintTop_to
TopOf="parent" />

   <TableLayout

android:id="@+id/tableLayo
ut"

android:layout_width="0dp"

android:layout_height="wrap
_content"

android:layout_marginTop="
135dp"

android:background="@draw
able/table_border"

android:shrinkColumns="*"

android:stretchColumns="*"

app:layout_constraintEnd_to
EndOf="parent"

app:layout_constraintStart_to
StartOf="parent"

app:layout_constraintTop_to
TopOf="parent">

      <TableRow>

         <TextView

android:background="@draw
able/table_border"

android:padding="10dp"

android:text="METHOD"

android:textStyle="bold" />

         <TextView

android:background="@draw
able/table_border"

android:padding="10dp"

android:text="DATE"

android:textStyle="bold" />

         <TextView

android:background="@draw
able/table_border"

android:padding="10dp"

android:text="TIME"

android:textStyle="bold" />

         <TextView

android:background="@draw
able/table_border"

android:padding="10dp"

android:text="REMARKS"

android:textStyle="bold" />
      </TableRow>

      <TableRow>

         <TextView

android:id="@+id/table11"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

         <TextView

android:id="@+id/table12"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

         <TextView
```

```
android:id="@+id/table13"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/table14"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />
    </TableRow>

    <TableRow>

        <TextView

android:id="@+id/table21"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/table22"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/table23"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/table24"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />
    </TableRow>

    <TableRow>

        <TextView

android:id="@+id/table31"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/table32"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/table33"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/table34"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />
    </TableRow>

    <TableRow>

        <TextView

android:id="@+id/table41"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/table42"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/table43"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/table44"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />
    </TableRow>

    <TableRow>

        <TextView

android:id="@+id/table51"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/table52"

android:background="@draw
able/table_border"
```

```
android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/table53"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/table54"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />
    </TableRow>

    <TableRow>

        <TextView

android:id="@+id/table61"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/table62"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/table63"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/table64"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />
    </TableRow>

    <TableRow>

        <TextView

android:id="@+id/table71"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/table72"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/table73"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/table74"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />
    </TableRow>

    <TableRow>

        <TextView

android:id="@+id/table81"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/table82"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/table83"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/table84"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />
    </TableRow>

    <TableRow>

        <TextView

android:id="@+id/table91"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView
```

```
android:id="@+id/table92"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/table93"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/table94"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />
    </TableRow>

    <TableRow>

        <TextView

android:id="@+id/table101"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/table102"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/table103"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />

        <TextView

android:id="@+id/table104"

android:background="@draw
able/table_border"

android:padding="8dp"
            android:text="" />
    </TableRow>

  </TableLayout>
</androidx.constraintlayout.
widget.ConstraintLayout>
```

AboutUs.java

```
package
com.example.waterworksai;

import android.os.Bundle;

import
androidx.appcompat.app.App
CompatActivity;

public class AboutUs extends
AppCompatActivity {
   @Override
   protected void
onCreate(Bundle
savedInstanceState) {

super.onCreate(savedInstance
State);

setContentView(R.layout.abo
utus);
   }
}
```

AboutUs.xml

```
<?xml version="1.0"
encoding="utf-8"?>
<androidx.constraintlayout.w
idget.ConstraintLayout
xmlns:android="http://schem
as.android.com/apk/res/andro
id"

xmlns:app="http://schemas.a
ndroid.com/apk/res-auto"

xmlns:tools="http://schemas.
android.com/tools"

android:id="@+id/relativeLa
yout2"

android:layout_width="match
_parent"

android:layout_height="matc
h_parent"

android:background="@draw
able/wp"
   tools:context=".Directory"
   tools:ignore="ExtraText">

   <TextView

android:id="@+id/textView"

android:layout_width="wrap
_content"

android:layout_height="wrap
_content"

android:fontFamily="@font/
ubuntub"
      android:text="ABOUT
US"

android:textColor="@color/
white"
      android:textSize="50dp"

app:layout_constraintBottom
_toBottomOf="parent"

app:layout_constraintEnd_to
EndOf="parent"

app:layout_constraintStart_to
StartOf="parent"

app:layout_constraintTop_to
TopOf="parent"

app:layout_constraintVertical
_bias="0.066" />


   <ImageView

android:id="@+id/imageVie
w2"

android:layout_width="wrap
_content"

android:layout_height="wrap
_content"

app:layout_constraintBottom
_toBottomOf="parent"

app:layout_constraintEnd_to
EndOf="parent"

app:layout_constraintHorizon
tal_bias="0.0"

app:layout_constraintStart_to
StartOf="parent"

app:layout_constraintTop_to
TopOf="parent"

app:layout_constraintVertical
_bias="0.222"

app:srcCompat="@drawable/
logo" />

   <TextView

android:id="@+id/textView4
"

android:layout_width="wrap
_content"

android:layout_height="wrap
_content"

android:fontFamily="@font/
ubuntur"

android:text="WaterWorks
AI is a fertigation system
capable of controlling and
optimizing water and
fertilizer usage in the process
of irrigation and fertigation. It
is connected to various water-
related sensors which analyze
information about water flow,
water pressure level, and
water level status.**"

android:textAlignment="cent
er"

android:textColor="@color/
white"
      android:textSize="3mm"

app:layout_constraintBottom
_toBottomOf="parent"

app:layout_constraintEnd_to
EndOf="parent"

app:layout_constraintHorizon
tal_bias="0.0"
```

```
app:layout_constraintStart_to
StartOf="parent"

app:layout_constraintTop_to
TopOf="parent"

app:layout_constraintVertical
_bias="0.7" />

</androidx.constraintlayout.
widget.ConstraintLayout>
```

PHP & SQL

Login.php

```
<?php

$username =
$_GET['username'];
$password =
$_GET['password'];

$con=mysqli_connect("localh
ost","u258643442_WaterGua
rden","4Lb{}V*+LZ(VneZa"
);// server, user, password

//Select Database
mysqli_select_db($con,'u258
643442_WaterWorksAI') or
die('Cannot select the DB');

// Check the connection
if (mysqli_connect_errno()) {
   echo "Failed to connect to
MySQL: " .
mysqli_connect_error();
}

$sql       =   "SELECT *
FROM users WHERE
username = '$username'
LIMIT 1";
$result    =   $con-
>query($sql);

if ($result->num_rows > 0) {

   while ($row = $result-
>fetch_assoc())
   {
      $checkpass =
$row['password'];
      if
(password_verify($password,
$checkpass)) {
         echo "Success";
      } else {
         echo 'Invalid
password!';
      }
   }

} else {
      echo "Unknown Error";
}

?>
```

Scheduling.php

```
<?php

$method = $_GET['value1'];
$datetime = $_GET['value2'];

$con=mysqli_connect("localhost","u258643442_WaterGuarden","4Lb{}V*+LZ(VneZa");// server, user, password

//Select Database
mysqli_select_db($con,'u258643442_WaterWorksAI') or die('Cannot select the DB');

// Check the connection
if (mysqli_connect_errno()) {
  echo "Failed to connect to MySQL: " . mysqli_connect_error();
}

$arr = explode(" ",$datetime,2);

if ($arr[0] == "Date"||$arr[1] == "Time") {
   echo "Failed";
} else {
   //Send schedule
   $query = "INSERT INTO schedule(method,datetime,status) VALUES('$method','$datetime','UPCOMING')";
   $result = mysqli_query($con,$query) or die('Errant query: '.$query);

   echo "Success";
}

?>
```

Monitoring.php

```
<?php

$con=mysqli_connect("localhost","u258643442_WaterGuarden","4Lb{}V*+LZ(VneZa");// server, user, password

$sql = "SELECT * FROM schedule WHERE status = 'DONE' OR status = 'CANCELLED' ORDER BY id DESC LIMIT 10";
   $result = $con->query($sql);

   if ($result->num_rows > 0) {

   while ($row = $result->fetch_assoc())
   {
      echo $row['method']. " " . $row['datetime'];
      echo '<br>';
   }

   } else {
      echo "None";
   }

?>
```

Check-history.php

```
<?php

$con=mysqli_connect("localhost","u258643442_WaterGuarden","4Lb{}V*+LZ(VneZa");// server, user, password

//Select Database
mysqli_select_db($con,'u258643442_WaterWorksAI') or die('Cannot select the DB');

// Check the connection
if (mysqli_connect_errno()) {
   echo "Failed to connect to MySQL: " . mysqli_connect_error();
  }

   $sql = "SELECT * FROM schedule WHERE status = 'DONE' OR status = 'CANCELLED' ORDER BY id DESC LIMIT 1";
   $result = $con->query($sql);

   if ($result->num_rows > 0) {

   while ($row = $result->fetch_assoc())
   {
      echo $row['method']. " " . $row['datetime']. " " . $row['status'];
      echo '<br>';
   }

   } else {
      echo "Unknown Error";
   }

?>
```

Waterlevel.php

```
<?php

$waterlevel = $_GET['value1'];

$con=mysqli_connect("localhost","u258643442_WaterGuarden","4Lb{}V*+LZ(VneZa");// server, user, password

//Select Database
mysqli_select_db($con,'u258643442_WaterWorksAI') or die('Cannot select the DB');

// Check the connection
if (mysqli_connect_errno()) {
  echo "Failed to connect to MySQL: " . mysqli_connect_error();
}

//Now update the water level value
$query = "UPDATE fertigation SET water_level = '$waterlevel'
WHERE id=9999";
$result = mysqli_query($con,$query) or die('Errant query: '.$query);

?>
```

sendData.php

```
<?php

$flowrate = $_GET['value1'];
$pressure = $_GET['value2'];
```

```
$sched = $_GET['value3'];
$press1 = $_GET['value4'];
$press2 = $_GET['value5'];

$con=mysqli_connect("localh
ost","u258643442_WaterGua
rden","4Lb{}V*+LZ(VneZa"
);// server, user, password

//Select Database
mysqli_select_db($con,'u258
643442_WaterWorksAI') or
die('Cannot select the DB');

// Check the connection
if (mysqli_connect_errno()) {
  echo "Failed to connect to
MySQL: " .
mysqli_connect_error();
}

//Now update the values
$query = "UPDATE
fertigation SET water_flow =
'$flowrate', water_pressure =
'$pressure', status =
'ACTIVE'
WHERE id=9999";
$result =
mysqli_query($con,$query)
or die('Errant query:
'.$query);

include 'CascadeData.php';
dataSend($flowrate,$press1,$
press2,$pressure,$sched);

?>
```

CascadeData.php

```
<?php

function
dataSend($flowrate,$press1,$
press2,$pressure,$sched) {


$con=mysqli_connect("localh
ost","u258643442_WaterGua
rden","4Lb{}V*+LZ(VneZa"
);// server, user, password

   //Select Database

mysqli_select_db($con,'u258
643442_WaterWorksAI') or
die('Cannot select the DB');

   // Check the connection
   if
(mysqli_connect_errno()) {
     echo "Failed to connect to
MySQL: " .
mysqli_connect_error();
   }

   //Now update the values
   $query = "INSERT INTO
data(flowrate,press_1,press_2
,pressure,sched)
VALUES('$flowrate',$press1,
$press2,'$pressure','$sched')";
   $result =
mysqli_query($con,$query)
or die('Errant query:
'.$query);

}

?>
```

Cancel.php

```
<?php

$sched = $_GET['value1'];

$con=mysqli_connect("localh
ost","u258643442_WaterGua
rden","4Lb{}V*+LZ(VneZa"
);// server, user, password

//Select Database
mysqli_select_db($con,'u258
643442_WaterWorksAI') or
die('Cannot select the DB');

// Check the connection
if (mysqli_connect_errno()) {
  echo "Failed to connect to
MySQL: " .
mysqli_connect_error();
}

//Now update the status value
$query = "UPDATE schedule
SET status='CANCELLED'
WHERE datetime='$sched'";
$result =
mysqli_query($con,$query)
or die('Errant query:
'.$query);

?>
```

Success.php

```
<?php

$sched = $_GET['value1'];

$con=mysqli_connect("localh
ost","u258643442_WaterGua
rden","4Lb{}V*+LZ(VneZa"
);// server, user, password

//Select Database
mysqli_select_db($con,'u258
643442_WaterWorksAI') or
die('Cannot select the DB');

// Check the connection
if (mysqli_connect_errno()) {
  echo "Failed to connect to
MySQL: " .
mysqli_connect_error();
}

//Now update the status value
$query = "UPDATE schedule
SET status = 'DONE'
WHERE datetime='$sched'";
$result =
mysqli_query($con,$query)
or die('Errant query:
'.$query);

echo "Complete";

?>
```

Ongoing.php

```
<?php

$sched = $_GET['value1'];

$con=mysqli_connect("localh
ost","u258643442_WaterGua
rden","4Lb{}V*+LZ(VneZa"
);// server, user, password

//Select Database
mysqli_select_db($con,'u258
643442_WaterWorksAI') or
die('Cannot select the DB');
```

Disconnect.php

```
<?php

$con=mysqli_connect("localhost","u258643442_WaterGuarden","4Lb{}V*+LZ(VneZa");// server, user, password

//Select Database
mysqli_select_db($con,'u258643442_WaterWorksAI') or die('Cannot select the DB');

// Check the connection
if (mysqli_connect_errno()) {
  echo "Failed to connect to MySQL: " . mysqli_connect_error();
}

//Now update the status value
$query = "UPDATE fertigation SET status = 'INACTIVE'
WHERE id = 9999";
$result = mysqli_query($con,$query) or die('Errant query: '.$query);

?>
```

Register.php

```
<?php

$username = $_GET['value1'];
$password = $_GET['value2'];

$con=mysqli_connect("localhost","u258643442_WaterGuarden","4Lb{}V*+LZ(VneZa");// server, user, password

//Select Database
mysqli_select_db($con,'u258643442_WaterWorksAI') or die('Cannot select the DB');

// Check the connection
if (mysqli_connect_errno()) {
   echo "Failed to connect to MySQL: " . mysqli_connect_error();
}

$hash = password_hash($password, PASSWORD_DEFAULT);

$sql = "INSERT INTO users (username,password) VALUES ($username,$hash)";
$result = $con->query($sql);

?>
```

ANNEX III
EVALUATION FORMS

WATER GUARDEN: WATERWORKS AI SURVEY FORM

Introduction: The students involved in the study need to conduct a survey for the evaluation of different aspects of the technology developed in the research entitled ***"WATERWORKS - AI: DEVELOPMENT OF A SOLAR-POWERED AUTOMATED FERTIGATION SYSTEM WITH IRRIGATION SCHEDULING AND WATER FLOW CONTROL SYSTEM FOR FIELD CROPS UTILIZING DRIP IRRIGATION WITH MOBILE APPLICATION".***

It is expected that the questionnaire will take about 15 minutes to complete. If you consent to participate, your responses will be kept confidential. The information provided will be used solely for the purpose of this research project and only aggregated results will be reported in reputable acadcemic publications. No persons other than my supervisors and I will have access to the information you provide. Your participation is voluntary, and you are free to withdraw consent at any time and to withdraw any unprocessed data you have previously supplied. Upon completion of the research, all questionnaires will be securely stored.
(Inaasahan na ang talatanungan ay aabutin ng 15 minuto upang makumpleto. Kung pumayag kang lumahok, ang iyong mga tugon ay panatilihing kumpidensyal. Ang impormasyong ibinigay ay gagamitin lamang para sa layunin ng proyektong ito ng pananaliksik at ang mga pinagsama-samang mga resulta ay maiulat sa kagalang-galang na mga publikasyong pang-akademiko. Walang ibang tao maliban sa aking mga superbisor at magkakaroon ako ng access sa impormasyong iyong ibinibigay. Ang iyong pakikilahok ay kusang-loob, at malaya kang mag-alis ng pahintulot sa anumang oras at mag-alis ng anumang hindi pa nasuri na data na dati mong naibigay. Kapag natapos ang pananaliksik, ang lahat ng mga talatanungan ay ligtas na maiimbak.)

NAME (PANGALAN): John Aron C. Balaquiate	AGE (EDAD): 18
GENDER (KASARIAN): Male	OCCUPATION (TRABAHO): Student

AWARENESS AND FAMILIARITY WITH THE PROJECT

Do you have any prior experience or knowledge about similar technologies?
(Mayroon ka bang naunang karanasan o kaalaman tungkol sa mga katulad na teknolohiya?) *Answer:* Oo

TECHNOLOGY EVALUATION

	STRONGLY DISAGREE	DISAGREE	AGREE	STRONGLY AGREE
IRRIGATION/FERITGATION SYSTEM				
1. The automated fertigation system is more convenient than the conventional method. **(Ang awtomatikong sistema ng fertigasyon ay mas maginhawa kaysa sa nakasanayan na pamamaraan.)**			✓	
2. The use of solar panels as power source is beneficial to the local farmers. **(Ang paggamit ng mga solar panel bilang mapagkukunan ng kuryente ay kapaki-pakinabang sa mga lokal na magsasaka.)**			✓	
3. The project lessens the cost of maintenance of the irrigation system compared to the previous system used. **(Binabawasan ng proyekto ang gastos ng pagpapanatili ng sistema ng patubig kumpara sa nakaraang sistema na ginamit.)**				✓
4. The system outputs accurate amount of fertilizer. **(Ang sistema ay naglalabas ng tumpak na halaga ng pataba.)**			✓	
5. The system shows many inconsistencies on it. **(Ang systema ay nagpapakita ng maraming hindi pagkakapare-pareho dito.)**			✓	
6. The system's function increases efficiency on the farmer's job. **(Ang pagpapaandar ng sistema ay nagdaragdag ng kahusayan sa trabaho ng magsasaka.)**			✓	
7. The system lessens the existing farmer's workload. **(Binabawasan ng sistema ang umiiral na trabaho ng magsasaka.)**				✓
8. The project helps in conserving water using drip irrigation. **(Tumutulong ang proyekto sa pag-titipid ng tubig gamit ang drip na patubig.)**			✓	
9. The reliability of the system is satisfactory. **(Ang pagiging maaasahan ng system ay kasiya-siya.)**			✓	
MOBILE APPLICATION				
1. The project has a user-friendly interface for the mobile application and is very easy to access and control. **(Ang proyekto ay may user-friendly interface para sa mobile application at napakadaling ma-access at kontrolin.)**			✓	
2. The software has all the functions and capabilities I expected it to have. **(Ang software ay may lahat ng mga pag-andar at kakayahan na inaasahan kong magkaroon ito.)**			✓	
3. I can easily add and/or delete irrigation or fertigation schedules. **(Madali akong magdagdag at / o magtanggal ng mga iskedyul ng patubig.)**				✓
4. The gathered data of the system are very helpful. **(Ang natipon na data ng system ay lubos na kapaki-pakinabang.)**				✓
OVERALL FEEDBACK				
1. This project is useful to the overall work of the local farmers. **(Ang proyektong ito ay kapaki-pakinabang sa pangkalahatang gawain ng mga lokal na magsasaka.)**			✓	
2. This project gives me satisfaction by its performance. **(Ang proyektong ito ay nagbibigay sa akin ng kasiyahan sa pamamagitan ng pagganap nito.)**			✓	
3. I feel comfortable using this system. **(Kumportable ako sa paggamit ng sistemang ito.**			✓	

3. The project can be used for a long period of time in mind. **(Ang proyekto ay maaaring magamit para sa isang mahabang panahon.)**				✓
4. Through this project, it lets me widen my technological perspective. **(Sa pamamagitan ng proyektong ito, hinahayaan akong palawakin ang aking pananaw sa teknolohiya. 0**			✓	
5. I will recommend this project to other local farmers I know and work with. **(Irirekumenda ko ang proyektong ito sa iba ng mga lokal na magsasaka na kilala ko at nakikipagtulungan.)**				✓
6. The project fits perfectly with the needs of the farm. **(Ang proyekto ay umaangkop nang perpekto sa mga pangangailangan ng bukid.)**			✓	

BENEFITS AND IMPACT

What are the possible benefits and impacts of this project in your field of work?
(Ano ang mga posibleng benepisyo at epekto ng proyektong ito sa iyong larangan ng trabaho?)
Answer: mas mapapadali ang trabaho ng magsasaka at bawas din sa gastusin

SUGGESTION AND IMPROVEMENTS

Do you have any specific features or functionalities you would like to see added or modified?
(Mayroon ka bang anumang mga tukoy na tampok o pag-andar na nais mong makita ang idinagdag o binago?)
Answer: lakihan yung makina

USAGE AND ADOPTION

How likely is it for you to do a transition and use/adopt the project?
(Gaano kadalas para sa iyo na gumawa ng isang paglipat at gamitin / itangkilik ang proyekto?)
Answer: 99.9 %. kase bawas en hatchu at gastusin

Thank you for taking the time to complete this survey questionnaire. We greatly value your cooperation, and we are deeply grateful for your time and consideration.

If you have any questions or want to be kept updated regarding this project and/or willing to participate in future research, feel free to contact us on 09303014212 or 09163207552 (Jireh Dawn Cruz) or send an email to jirehdawn.cruz@tup.edu.ph or cruz.jirehdawn@gmail.com

amen

WATER GUARDEN: WATERWORKS AI SURVEY FORM

Introduction: The students involved in the study need to conduct a survey for the evaluation of different aspects of the technology developed in the research entitled ***"WATERWORKS - AI: DEVELOPMENT OF A SOLAR-POWERED AUTOMATED FERTIGATION SYSTEM WITH IRRIGATION SCHEDULING AND WATER FLOW CONTROL SYSTEM FOR FIELD CROPS UTILIZING DRIP IRRIGATION WITH MOBILE APPLICATION".***

It is expected that the questionnaire will take about 15 minutes to complete. If you consent to participate, your responses will be kept confidential. The information provided will be used solely for the purpose of this research project and only aggregated results will be reported in reputable academic publications. No persons other than my supervisors and I will have access to the information you provide. Your participation is voluntary, and you are free to withdraw consent at any time and to withdraw any unprocessed data you have previously supplied. Upon completion of the research, all questionnaires will be securely stored.
(Inaasahan na ang talatanungan ay aabutin ng 15 minuto upang makumpleto. Kung pumayag kang lumahok, ang iyong mga tugon ay panatilihing kumpidensyal. Ang impormasyong ibinigay ay gagamitin lamang para sa layunin ng proyektong ito ng pananaliksik at ang mga pinagsama-samang mga resulta ay maiulat sa kagalang-galang na mga publikasyong pang-akademiko. Walang ibang tao maliban sa aking mga superbisor at magkakaroon ako ng access sa impormasyong iyong ibinibigay. Ang iyong pakikilahok ay kusang-loob, at malaya kang mag-alis ng pahintulot sa anumang oras at mag-alis ng anumang hindi pa nasuri na data na dati mong naibigay. Kapag natapos ang pananaliksik, ang lahat ng mga talatanungan ay ligtas na maiimbak.)

NAME (PANGALAN): Joy-L	AGE (EDAD): 17
GENDER (KASARIAN): Male	OCCUPATION (TRABAHO): STUDENT / Farmer

AWARENESS AND FAMILIARITY WITH THE PROJECT

Do you have any prior experience or knowledge about similar technologies?
(Mayroon ka bang naunang karanasan o kaalaman tungkol sa mga katulad na teknolohiya?) *Answer:* Yes

TECHNOLOGY EVALUATION

	STRONGLY DISAGREE	DISAGREE	AGREE	STRONGLY AGREE
IRRIGATION/FERITGATION SYSTEM				
1. The automated fertigation system is more convenient than the conventional method. **(Ang awtomatikong sistema ng fertigasyon ay mas maginhawa kaysa sa nakasanayan na pamamaraan.)**			✓	
2. The use of solar panels as power source is beneficial to the local farmers. **(Ang paggamit ng mga solar panel bilang mapagkukunan ng kuryente ay kapaki-pakinabang sa mga lokal na magsasaka.)**				✓
3. The project lessens the cost of maintenance of the irrigation system compared to the previous system used. **(Binabawasan ng proyekto ang gastos ng pagpapanatili ng sistema ng patubig kumpara sa nakaraang sistema na ginamit.)**				✓
4. The system outputs accurate amount of fertilizer. **(Ang sistema ay naglalabas ng tumpak na halaga ng pataba.)**				✓
5. The system shows many inconsistencies on it. **(Ang systema ay nagpapakita ng maraming hindi pagkakapare-pareho dito.)**			✓	
6. The system's function increases efficiency on the farmer's job. **(Ang pagpapaandar ng sistema ay nagdaragdag ng kahusayan sa trabaho ng magsasaka.)**			✓	
7. The system lessens the existing farmer's workload. **(Binabawasan ng sistema ang umiiral na trabaho ng magsasaka.)**				✓
8. The project helps in conserving water using drip irrigation. **(Tumutulong ang proyekto sa pag-ttipid ng tubig gamit ang drip na patubig.)**				✓
9. The reliability of the system is satisfactory. **(Ang pagiging maaasahan ng system ay kasiya-siya.)**				✓
MOBILE APPLICATION				
1. The project has a user-friendly interface for the mobile application and is very easy to access and control. **(Ang proyekto ay may user-friendly interface para sa mobile application at napakadaling ma-access at kontrolin.)**				✓
2. The software has all the functions and capabilities I expected it to have. **(Ang software ay may lahat ng mga pag-andar at kakayahan na inaasahan kong magkaroon ito.)**				✓
3. I can easily add and/or delete irrigation or fertigation schedules. **(Madali akong magdagdag at / o magtanggal ng mga iskedyul ng patubig.)**				✓
4. The gathered data of the system are very helpful. **(Ang natipon na data ng system ay lubos na kapaki-pakinabang.)**				✓
OVERALL FEEDBACK				
1. This project is useful to the overall work of the local farmers. **(Ang proyektong ito ay kapaki-pakinabang sa pangkalahatang gawain ng mga lokal na magsasaka.)**				✓
2. This project gives me satisfaction by its performance. **(Ang proyektong ito ay nagbibigay sa akin ng kasiyahan sa pamamagitan ng pagganap nito.)**				✓
3. I feel comfortable using this system. **(Komportable ako sa paggamit ng sistemang ito.**				✓

3. The project can be used for a long period of time in mind. **(Ang proyekto ay maaaring magamit para sa isang mahabang panahon.)**				✓
4. Through this project, it lets me widen my technological perspective. **(Sa pamamagitan ng proyektong ito, hinahayaan akong palawakin ang aking pananaw sa teknolohiya. 0**				✓
5. I will recommend this project to other local farmers I know and work with. **(Irerekumenda ko ang proyektong ito sa ibang mga lokal na magsasaka na kilala ko at nakikipagtulungan.)**				✓
6. The project fits perfectly with the needs of the farm. **(Ang proyekto ay umaangkop nang perpekto sa mga pangangailangan ng bukid.)**			✓	

BENEFITS AND IMPACT

What are the possible benefits and impacts of this project in your field of work?
(Ano ang mga posibleng benepisyo at epekto ng proyektong ito sa iyong larangan ng trabaho?)
Answer: Mabatawasan ang fiskal na trabaho at mas mapapadali ang pagpapatubig gamit ang teknolohiya

SUGGESTION AND IMPROVEMENTS

Do you have any specific features or functionalities you would like to see added or modified?
(Mayroon ka bang anumang mga tukoy na tampok o pag-andar na nais mong makita ang idinagdag o binago?)
Answer: High quality materials and orig parts
improve enclosure

USAGE AND ADOPTION

How likely is it for you to do a transition and use/adopt the project?
(Gaano kadalas para sa iyo na gumawa ng isang paglipat at gamitin / itangkilik ang proyekto?)
Answer: 100% basic mas mapapadali ang gawain at iwasan nila ang teknolohiya at mapalawak ang isang sistema

Thank you for taking the time to complete this survey questionnaire. We greatly value your cooperation, and we are deeply grateful for your time and consideration.

If you have any questions or want to be kept updated regarding this project and/or willing to participate in future research, feel free to contact us on 09303014212 or 09163207552 (Jireh Dawn Cruz) or send an email to jirehdawn.cruz@tup.edu.ph or cruz.jirehdawn@gmail.com.

WATER GUARDEN: WATERWORKS AI SURVEY FORM

Introduction: The students involved in the study need to conduct a survey for the evaluation of different aspects of the technology developed in the research entitled ***"WATERWORKS - AI: DEVELOPMENT OF A SOLAR-POWERED AUTOMATED FERTIGATION SYSTEM WITH IRRIGATION SCHEDULING AND WATER FLOW CONTROL SYSTEM FOR FIELD CROPS UTILIZING DRIP IRRIGATION WITH MOBILE APPLICATION".***

It is expected that the questionnaire will take about 15 minutes to complete. If you consent to participate, your responses will be kept confidential. The information provided will be used solely for the purpose of this research project and only aggregated results will be reported in reputable academic publications. No persons other than my supervisors and I will have access to the information you provide. Your participation is voluntary, and you are free to withdraw consent at any time and to withdraw any unprocessed data you have previously supplied. Upon completion of the research, all questionnaires will be securely stored.
(Inaasahan na ang talatanungan ay aabutin ng 15 minuto upang makumpleto. Kung pumayag kang lumahok, ang iyong mga tugon ay panatilihing kumpidensyal. Ang impormasyong ibinigay ay gagamitin lamang para sa layunin ng proyektong ito ng pananaliksik at ang mga pinagsama-samang mga resulta ay maiulat sa kagalang-galang na mga publikasyong pang-akademiko. Walang ibang tao maliban sa aking mga superbisor at magkakaroon ako ng access sa impormasyong iyong ibinibigay. Ang iyong pakikilahok ay kusang-loob, at malaya kang mag-alis ng pahintulot sa anumang oras at mag-alis ng anumang hindi pa nasuri na data na dati mong naibigay. Kapag natapos ang pananaliksik, ang lahat ng mga talatanungan ay ligtas na maiimbak.)

NAME (PANGALAN): HERYANDE M. DELA PUENTE	AGE (EDAD): 56
GENDER (KASARIAN): MALE	OCCUPATION (TRABAHO):

AWARENESS AND FAMILIARITY WITH THE PROJECT

Do you have any prior experience or knowledge about similar technologies?
(Mayroon ka bang naunang karanasan o kaalaman tungkol sa mga katulad na teknolohiya?) *Answer:*

WALA

8. The project helps in conserving water using drip irrigation. **(Tumutulong ang proyekto sa pag-tiipid ng tubig gamit ang drip na patubig.)**			✓	
9. The reliability of the system is satisfactory. **(Ang pagiging maaasahan ng system ay kasiya-siya.)**			✓	
MOBILE APPLICATION				
1. The project has a user-friendly interface for the mobile application and is very easy to access and control. **(Ang proyekto ay may user-friendly interface para sa mobile application at napakadaling ma-access at kontrolin.)**			✓	
2. The software has all the functions and capabilities I expected it to have. **(Ang software ay may lahat ng mga pag-andar at kakayahan na inaasahan kong magkaroon ito.)**			✓	
3. I can easily add and/or delete irrigation or fertigation schedules. **(Madali akong magdagdag at / o magtanggal ng mga likedyul ng patubig.)**			✓	
4. The gathered data of the system are very helpful. **(Ang natipon na data ng system ay lubos na kapaki-pakinabang.)**			✓	
OVERALL FEEDBACK				
1. This project is useful to the overall work of the local farmers. **(Ang proyektong ito ay kapaki-pakinabang sa pangkalahatang gawain ng mga lokal na magsasaka.)**			✓	
2. This project gives me satisfaction by its performance. **(Ang proyektong ito ay nagbibigay sa akin ng kasiyahan sa pamamagitan ng pagganap nito.)**			✓	
3. I feel comfortable using this system. **(Kumportable ako sa paggamit ng sistemang ito.**			✓	

TECHNOLOGY EVALUATION

	STRONGLY DISAGREE	DISAGREE	AGREE	STRONGLY AGREE
IRRIGATION/FERTIGATION SYSTEM				
1. The automated fertigation system is more convenient than the conventional method. **(Ang awtomatikong sistema ng fertigasyon ay mas maginhawa kaysa sa nakasanayan na pamamaraan.)**			✓	
2. The use of solar panels as power source is beneficial to the local farmers. **(Ang paggamit ng mga solar panel bilang mapagkukunan ng kuryente ay kapaki-pakinabang sa mga lokal na magsasaka.)**			✓	
3. The project lessens the cost of maintenance of the irrigation system compared to the previous system used. **(Binabawasan ng proyekto ang gastos ng pagpapanatili ng sistema ng patubig kumpara sa nakarsang sistema na ginamit.)**			✓	
4. The system outputs accurate amount of fertilizer. **(Ang sistema ay naglalabas ng tumpak na halaga ng pataba.)**			✓	
5. The system shows many inconsistencies on it. **(Ang systema ay nagpapakita ng maraming hindi pagkakapare-pareho dito.)**			✓	
6. The system's function increases efficiency on the farmer's job. **(Ang pagpapaandar ng sistema ay nagdaragdag ng kahusayan sa trabaho ng magsasaka.)**			✓	
7. The system lessens the existing farmer's workload. **(Binabawasan ng sistema ang umiiral na trabaho ng magsasaka.)**			✓	

3. The project can be used for a long period of time in mind. **(Ang proyekto ay maaaring magamit para sa isang mahabang panahon.)**			✓	
4. Through this project, it lets me widen my technological perspective. **(Sa pamamagitan ng proyektong ito, hinahayaan akong palawakin ang aking pananaw sa teknolohiya. 0**			✓	
5. I will recommend this project to other local farmers I know and work with. **(Inirerekumenda ko ang proyektong ito sa iBang mga lokal na magsasaka na kilala ko at nakikipagtulungan.)**			✓	
6. The project fits perfectly with the needs of the farm. **(Ang proyekto ay umaangkop nang perpekto sa mga pangangailangan ng bukid.)**			✓	

BENEFITS AND IMPACT

What are the possible benefits and impacts of this project in your field of work?
(Ano ang mga posibleng benepisyo at epekto ng proyektong ito sa iyong larangan ng trabaho?)
Answer:

MABILIS ANG TRABAHO

SUGGESTION AND IMPROVEMENTS

Do you have any specific features or functionalities you would like to see added or modified?
(Mayroon ka bang anumang mga tukoy na tampok o pag-andar na nais mong makita ang idinagdag o binago?)
Answer:

PALAKIHIN ANG PROYEKTO

USAGE AND ADOPTION

How likely is it for you to do a transition and use/adopt the project?
(Gaano kadalas para sa iyo na gumawa ng isang paglipat at gamitin / itangkilik ang proyekto?)
Answer:

MATAAS NA TYANSA

Thank you for taking the time to complete this survey questionnaire. We greatly value your cooperation, and we are deeply grateful for your time and consideration.

If you have any questions or want to be kept updated regarding this project and/or willing to participate in future research, feel free to contact us on 09303014212 or 09163207552 (Jireh Dawn Cruz) or send an email to jirehdawn.cruz@tup.edu.ph or cruz.jirehdawn@gmail.com.

WATER GUARDEN: WATERWORKS AI SURVEY FORM

Introduction: The students involved in the study need to conduct a survey for the evaluation of different aspects of the technology developed in the research entitled ***"WATERWORKS - AI: DEVELOPMENT OF A SOLAR-POWERED AUTOMATED FERTIGATION SYSTEM WITH IRRIGATION SCHEDULING AND WATER FLOW CONTROL SYSTEM FOR FIELD CROPS UTILIZING DRIP IRRIGATION WITH MOBILE APPLICATION".***

It is expected that the questionnaire will take about 15 minutes to complete. If you consent to participate, your responses will be kept confidential. The information provided will be used solely for the purpose of this research project and only aggregated results will be reported in reputable academic publications. No persons other than my supervisors and I will have access to the information you provide. Your participation is voluntary, and you are free to withdraw consent at any time and to withdraw any unprocessed data you have previously supplied. Upon completion of the research, all questionnaires will be securely stored.
(Inaasahan na ang talatanungan ay aabutin ng 15 minuto upang makumpleto. Kung pumayag kang lumahok, ang iyong mga tugon ay panatilihing kumpidensyal. Ang impormasyong ibinigay ay gagamitin lamang para sa layunin ng proyektong ito ng pananaliksik at ang mga pinagsama-samang mga resulta ay maiulat sa kagalang-galang na mga publikasyong pang-akademiko. Walang ibang tao maliban sa aking mga superbisor at magkakaroon ako ng access sa impormasyong iyong ibinibigay. Ang iyong pakikilahok ay kusang-loob, at malaya kang mag-alis ng pahintulot sa anumang oras at mag-alis ng anumang hindi pa nasuri na data na dati mong naibigay. Kapag natapos ang pananaliksik, ang lahat ng mga talatanungan ay ligtas na maiimbak.)

NAME (PANGALAN): JEELED S. DELAFIELDE AGE (EDAD): 48

GENDER (KASARIAN): MALE OCCUPATION (TRABAHO): FARMER/DRIVER

AWARENESS AND FAMILIARITY WITH THE PROJECT

Do you have any prior experience or knowledge about similar technologies?
(Mayroon ka bang naunang karanasan o kaalaman tungkol sa mga katulad na teknolohiya?) Answer: Wala, ngayun palang

TECHNOLOGY EVALUATION

	STRONGLY DISAGREE	DISAGREE	AGREE	STRONGLY AGREE
IRRIGATION/FERITGATION SYSTEM				
1. The automated fertigation system is more convenient than the conventional method. **(Ang awtomatikong sistema ng fertigasyon ay mas maginhawa kaysa sa nakasanayan na pamamaraan.)**			✓	
2. The use of solar panels as power source is beneficial to the local farmers. **(Ang paggamit ng mga solar panel bilang mapagkukunan ng kuryente ay kapaki-pakinabang sa mga lokal na magsasaka.)**			✓	
3. The project lessens the cost of maintenance of the irrigation system compared to the previous system used. **(Binabawasan ng proyekto ang gastos ng pagpapanatili ng sistema ng patubig kumpara sa nakaraang sistema na ginamit.)**				✓
4. The system outputs accurate amount of fertilizer. **(Ang sistema ay naglalabas ng tumpak na halaga ng pataba.)**			✓	
5. The system shows many inconsistencies on it. **(Ang systema ay nagpapakita ng maraming hindi pagkakapare-pareho dito.)**		✓	✓	
6. The system's function increases efficiency on the farmer's job. **(Ang pagpapaandar ng sistema ay nagdaragdag ng kahusayan sa trabaho ng magsasaka.)**			✓	
7. The system lessens the existing farmer's workload. **(Binabawasan ng sistema ang umiiral na trabaho ng magsasaka.)**			✓	
8. The project helps in conserving water using drip irrigation. **(Tumutulong ang proyekto sa pag-titipid ng tubig gamit ang drip na patubig.)**		✓		
9. The reliability of the system is satisfactory. **(Ang pagiging maaasahan ng system ay kasiya-siya.)**			✓	
MOBILE APPLICATION				
1. The project has a user-friendly interface for the mobile application and is very easy to access and control. **(Ang proyekto ay may user-friendly interface para sa mobile application at napakadaling ma-access at kontrolin.)**			✓	
2. The software has all the functions and capabilities I expected it to have. **(Ang software ay may lahat ng mga pag-andar at kakayahan na inaasahan kong magkaroon ito.)**			✓	
3. I can easily add and/or delete irrigation or fertigation schedules. **(Madali akong magdagdag at / o magtanggal ng mga iskedyul ng patubig.)**			✓	
4. The gathered data of the system are very helpful. **(Ang natipon na data ng system ay lubos na kapaki-pakinabang.)**			✓	
OVERALL FEEDBACK				
1. This project is useful to the overall work of the local farmers. **(Ang proyektong ito ay kapaki-pakinabang sa pangkalahatang gawain ng mga lokal na magsasaka.)**			✓	
2. This project gives me satisfaction by its performance. **(Ang proyektong ito ay nagbibigay sa akin ng kasiyahan sa pamamagitan ng paggana nito.)**			✓	
3. I feel comfortable using this system. **(Kumportable ako sa paggamit ng sistemang ito.**			✓	

3. The project can be used for a long period of time in mind. **(Ang proyekto ay maaaring magamit para sa isang mahabang panahon.)**			✓
4. Through this project, it lets me widen my technological perspective. **(Sa pamamagitan ng proyektong ito, hinahayaan akong palawakin ang aking pananaw sa teknolohiya. 0**			✓
5. I will recommend this project to other local farmers I know and work with. **(Inirerekumenda ko ang proyektong ito sa ibang mga lokal na magsasaka na kilala ko at nakikipagtulungan.)**			✓
6. The project fits perfectly with the needs of the farm. **(Ang proyekto ay umaangkop nang perpekto sa mga pangangailangan ng bukid.)**			✓

BENEFITS AND IMPACT

What are the possible benefits and impacts of this project in your field of work?
(Ano ang mga posibleng benepisyo at epekto ng proyektong ito sa iyong larangan ng trabaho?)
Answer: PINADADALI NYA ANG TRABAHO SA BUKID/TUBIGAN BAWAS ORAS SATRABAHO AT NAGAGAWA PA ANG IBA

SUGGESTION AND IMPROVEMENTS

Do you have any specific features or functionalities you would like to see added or modified?
(Mayroon ka bang anumang mga tukoy na tampok o pag-andar na nais mong makita ang idinagdag o binago?)
Answer: Maganda naman ang layunin nila at makaking Tulong sa magsasaka

USAGE AND ADOPTION

How likely is it for you to do a transition and use/adopt the project?
(Gaano kadalas para sa iyo na gumawa ng isang paglipat at gamitin / itangkilik ang proyekto?)
Answer: kung maiaayos at mapapagandka pa ang proyekto ay willing namin na gamitin

Thank you for taking the time to complete this survey questionnaire. We greatly value yonr cooperation, and we are deeply grateful for your time and consideration.

If you have any questions or want to be kept updated regarding this project and/or willing to participate in future research, feel free to contact us on 09303014212 or 09163207552 (Jireh Dawn Cruz) or send an email to jirehdawn.cruz@tup.edu.ph or cruz.jirehdawn@gmail.com.

Jdela Fuente

WATER GUARDEN: WATERWORKS AI SURVEY FORM

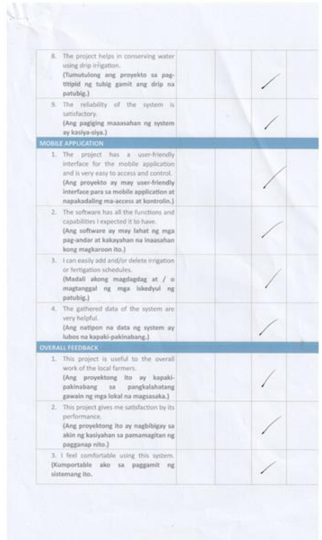
Introduction: The students involved in the study need to conduct a survey for the evaluation of different aspects of the technology developed in the research entitled ***"WATERWORKS - AI: DEVELOPMENT OF A SOLAR-POWERED AUTOMATED FERTIGATION SYSTEM WITH IRRIGATION SCHEDULING AND WATER FLOW CONTROL SYSTEM FOR FIELD CROPS UTILIZING DRIP IRRIGATION WITH MOBILE APPLICATION".***

It is expected that the questionnaire will take about 15 minutes to complete. If you consent to participate, your responses will be kept confidential. The information provided will be used solely for the purpose of this research project and only aggregated results will be reported in reputable academic publications. No persons other than my supervisors and I will have access to the information you provide. Your participation is voluntary, and you are free to withdraw consent at any time and to withdraw any unprocessed data you have previously supplied. Upon completion of the research, all questionnaires will be securely stored.
(Inaasahan na ang talatanungan ay aabutin ng 15 minuto upang makumpleto. Kung pumayag kang lumahok, ang iyong mga tugon ay panatilihing kumpidensyal. Ang impormasyong ibinigay ay gagamitin lamang para sa layunin ng proyektong ito ng pananaliksik at ang mga pinagsama-samang mga resulta ay maiulat sa kagalang-galang na mga publikasyong pang-akademiko. Walang ibang tao maliban sa aking mga superbisor at magkakaroon ako ng access sa impormasyong iyong ibinibigay. Ang iyong pakikilahok ay kusang-loob, at malaya kang mag-alis ng pahintulot sa anumang oras at mag-alis ng anumang hindi pa nasuri na data na dati mong naibigay. Kapag natapos ang pananaliksik, ang lahat ng mga talatanungan ay ligtas na maiimbak.)

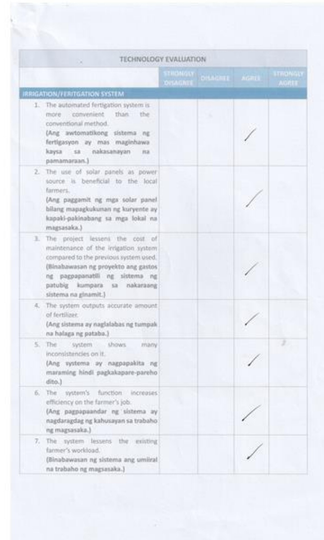
NAME (PANGALAN): John Josue C. Dela [illegible]	AGE (EDAD): 15
GENDER (KASARIAN): lalaki	OCCUPATION (TRABAHO): student

AWARENESS AND FAMILIARITY WITH THE PROJECT

Do you have any prior experience or knowledge about similar technologies?
(Mayroon ka bang naunang karanasan o kaalaman tungkol sa mga katulad na teknolohiya?) *Answer:* wala po

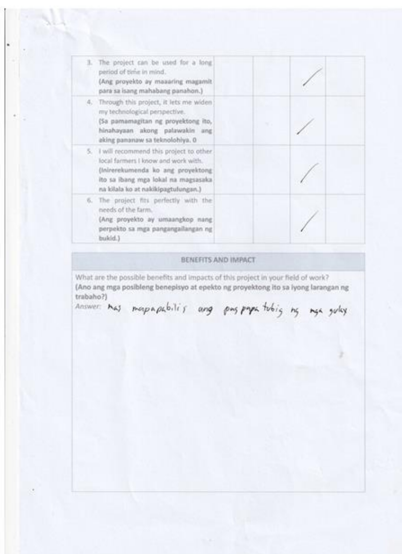


8. The project helps in conserving water using drip irrigation. **(Tumutulong ang proyekto sa pag-titipid ng tubig gamit ang drip na patubig.)**			✓	
9. The reliability of the system is satisfactory. **(Ang pagiging maaasahan ng system ay kasiya-siya.)**			✓	
MOBILE APPLICATION				
1. The project has a user-friendly interface for the mobile application and is very easy to access and control. **(Ang proyekto ay may user-friendly interface para sa mobile application at napakadaling ma-access at kontrolin.)**			✓	
2. The software has all the functions and capabilities I expected it to have. **(Ang software ay may lahat ng mga pag-andar at kakayahan na inaasahan kong magkaroon ito.)**			✓	
3. I can easily add and/or delete irrigation or fertigation schedules. **(Madali akong magdagdag at / o magtanggal ng mga iskedyul ng patubig.)**			✓	
4. The gathered data of the system are very helpful. **(Ang natipon na data ng system ay lubos na kapaki-pakinabang.)**			✓	
OVERALL FEEDBACK				
1. This project is useful to the overall work of the local farmers. **(Ang proyektong ito ay kapaki-pakinabang sa pangkalahatang gawain ng mga lokal na magsasaka.)**			✓	
2. This project gives me satisfaction by its performance. **(Ang proyektong ito ay nagbibigay sa akin ng kasiyahan sa pamamagitan ng pagganap nito.)**			✓	
3. I feel comfortable using this system. **(Kumportable ako sa paggamit ng sistemang ito.**			✓	



TECHNOLOGY EVALUATION

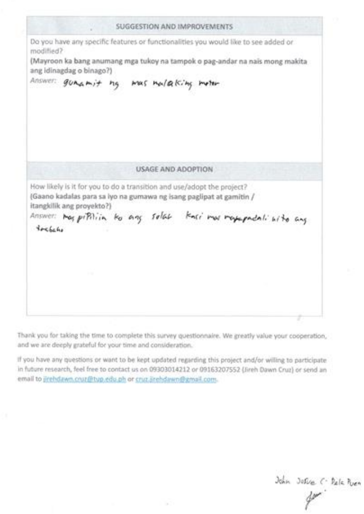
	STRONGLY DISAGREE	DISAGREE	AGREE	STRONGLY AGREE
IRRIGATION/FERITGATION SYSTEM				
1. The automated fertigation system is more convenient than the conventional method. **(Ang awtomatikong sistema ng fertigasyon ay mas maginhawa kaysa sa nakasanayan na pamamaraan.)**			✓	
2. The use of solar panels as power source is beneficial to the local farmers. **(Ang paggamit ng mga solar panel bilang mapagkukunan ng kuryente ay kapaki-pakinabang sa mga lokal na magsasaka.)**			✓	
3. The project lessens the cost of maintenance of the irrigation system compared to the previous system used. **(Binabawasan ng proyekto ang gastos ng pagpapanatili ng sistema ng patubig kumpara sa nakaraang sistema na ginamit.)**			✓	
4. The system outputs accurate amount of fertilizer. **(Ang sistema ay naglalabas ng tumpak na halaga ng pataba.)**			✓	
5. The system shows many inconsistencies on it. **(Ang systema ay nagpapakita ng maraming hindi pagkakapare-pareho dito.)**			✓	
6. The system's function increases efficiency on the farmer's job. **(Ang pagpapaandar ng sistema ay nagdaragdag ng kahusayan sa trabaho ng magsasaka.)**			✓	
7. The system lessens the existing farmer's workload. **(Binabawasan ng sistema ang umiiral na trabaho ng magsasaka.)**			✓	



3. The project can be used for a long period of time in mind. **(Ang proyekto ay maaaring magamit para sa isang mahabang panahon.)**			✓	
4. Through this project, it lets me widen my technological perspective. **(Sa pamamagitan ng proyektong ito, hinahayaan akong palawakin ang aking pananaw sa teknolohiya. 0**			✓	
5. I will recommend this project to other local farmers I know and work with. **(Inirerekumenda ko ang proyektong ito sa ibang mga lokal na magsasaka na kilala ko at nakikipagtulungan.)**			✓	
6. The project fits perfectly with the needs of the farm. **(Ang proyekto ay umaangkop nang perpekto sa mga pangangailangan ng bukid.)**			✓	

BENEFITS AND IMPACT

What are the possible benefits and impacts of this project in your field of work?
(Ano ang mga posibleng benepisyo at epekto ng proyektong ito sa iyong larangan ng trabaho?)
Answer: mas mapapabilis ang pagpapatubig ng mga gulay



SUGGESTION AND IMPROVEMENTS

Do you have any specific features or functionalities you would like to see added or modified?
(Mayroon ka bang anumang mga tukoy na tampok o pag-andar na nais mong makita ang idinagdag o binago?)
Answer: gumamit ng mas malaking motor

USAGE AND ADOPTION

How likely is it for you to do a transition and use/adopt the project?
(Gaano kadalas para sa iyo na gumawa ng isang paglipat at gamitin / itangkilik ang proyekto?)
Answer: mas pipiliin ko ang solar kasi mas mapapadali nito ang trabaho

Thank you for taking the time to complete this survey questionnaire. We greatly value your cooperation, and we are deeply grateful for your time and consideration.

If you have any questions or want to be kept updated regarding this project and/or willing to participate in future research, feel free to contact us on 09303014212 or 09163207552 (Jireh Dawn Cruz) or send an email to jirehdawn.cruz@tup.edu.ph or cruz.jirehdawn@gmail.com.

John Josue C. Dela [illegible]

WATER GUARDEN: WATERWORKS AI SURVEY FORM

Introduction: The students involved in the study need to conduct a survey for the evaluation of different aspects of the technology developed in the research entitled ***"WATERWORKS - AI: DEVELOPMENT OF A SOLAR-POWERED AUTOMATED FERTIGATION SYSTEM WITH IRRIGATION SCHEDULING AND WATER FLOW CONTROL SYSTEM FOR FIELD CROPS UTILIZING DRIP IRRIGATION WITH MOBILE APPLICATION".***

It is expected that the questionnaire will take about 15 minutes to complete. If you consent to participate, your responses will be kept confidential. The information provided will be used solely for the purpose of this research project and only aggregated results will be reported in reputable academic publications. No persons other than my supervisors and I will have access to the information you provide. Your participation is voluntary, and you are free to withdraw consent at any time and to withdraw any unprocessed data you have previously supplied. Upon completion of the research, all questionnaires will be securely stored.
(Inaasahan na ang talatanungan ay aabutin ng 15 minuto upang makumpleto. Kung pumayag kang lumahok, ang iyong mga tugon ay panatilihing kumpidensyal. Ang impormasyong ibinigay ay gagamitin lamang para sa layunin ng proyektong ito ng pananaliksik at ang mga pinagsama-samang mga resulta ay maiulat sa kagalang-galang na mga publikasyong pang-akademiko. Walang ibang tao maliban sa akin ang mga superbisor at magkakaroon ako ng access sa impormasyong iyong ibinibigay. Ang iyong pakikilahok ay kusang-loob, at malaya kang mag-alis ng pahintulot sa anumang oras at mag-alis ng anumang hindi pa nasuri na data na dati mong naibigay. Kapag natapos ang pananaliksik, ang lahat ng mga talatanungan ay ligtas na maiimbak.)

NAME (PANGALAN): ROMMEL SANTOS	AGE (EDAD): 45
GENDER (KASARIAN): M.	OCCUPATION (TRABAHO): FARMER

AWARENESS AND FAMILIARITY WITH THE PROJECT

Do you have any prior experience or knowledge about similar technologies?
(Mayroon ka bang naunang karanasan o kaalaman tungkol sa mga katulad na teknolohiya?) *Answer:* WALA

TECHNOLOGY EVALUATION

	STRONGLY DISAGREE	DISAGREE	AGREE	STRONGLY AGREE
IRRIGATION/FERTIGATION SYSTEM				
1. The automated fertigation system is more convenient than the conventional method. **(Ang awtomatikong sistema ng fertigasyon ay mas maginhawa kaysa sa nakasanayan na pamamaraan.)**			✓	
2. The use of solar panels as power source is beneficial to the local farmers. **(Ang paggamit ng mga solar panel bilang mapagkukunan ng kuryente ay kapaki-pakinabang sa mga lokal na magsasaka.)**			✓	
3. The project lessens the cost of maintenance of the irrigation system compared to the previous system used. **(Binabawasan ng proyekto ang gastos ng pagpapanatili ng sistema ng patubig kumpara sa nakarasang sistema na ginamit.)**		✓		
4. The system outputs accurate amount of fertilizer. **(Ang sistema ay naglalabas ng tumpak na halaga ng pataba.)**		✓		
5. The system shows many inconsistencies on it. **(Ang systema ay nagpapakita ng maraming hindi pagkakapare-pareho dito.)**			✓	
6. The system's function increases efficiency on the farmer's job. **(Ang pagpapaandar ng sistema ay nagdaragdag ng kahusayan sa trabaho ng magsasaka.)**			✓	
7. The system lessens the existing farmer's workload. **(Binabawasan ng sistema ang umiiral na trabaho ng magsasaka.)**			✓	
8. The project helps in conserving water using drip irrigation. **(Tumutulong ang proyekto sa pag-titipid ng tubig gamit ang drip na patubig.)**			✓	
9. The reliability of the system is satisfactory. **(Ang pagiging maaasahan ng system ay kasiya-siya.)**			✓	
MOBILE APPLICATION				
1. The project has a user-friendly interface for the mobile application and is very easy to access and control. **(Ang proyekto ay may user-friendly interface para sa mobile application at napakadaling ma-access at kontrolin.)**			✓	
2. The software has all the functions and capabilities I expected it to have. **(Ang software ay may lahat ng mga pag-andar at kakayahan na inaasahan kong magkaroon ito.)**			✓	
3. I can easily add and/or delete irrigation or fertigation schedules. **(Madali akong magdagdag at / o magtanggal ng mga iskedyul ng patubig.)**			✓	
4. The gathered data of the system are very helpful. **(Ang natipon na data ng system ay lubos na kapaki-pakinabang.)**			✓	
OVERALL FEEDBACK				
1. This project is useful to the overall work of the local farmers. **(Ang proyektong ito ay kapaki-pakinabang sa pangkalahatang gawain ng mga lokal na magsasaka.)**			✓	
2. This project gives me satisfaction by its performance. **(Ang proyektong ito ay nagbibigay sa akin ng kasiyahan sa pamamagitan ng pagganap nito.)**			✓	
3. I feel comfortable using this system. **(Komportable ako sa paggamit ng sistemang ito.**			✓	
3. The project can be used for a long period of time in mind. **(Ang proyekto ay maaaring magamit para sa isang mahabang panahon.)**			✓	
4. Through this project, it lets me widen my technological perspective. **(Sa pamamagitan ng proyektong ito, hinahayaan akong palawakin ang aking pananaw sa teknolohiya. 0**			✓	
5. I will recommend this project to other local farmers I know and work with. **(Irerekumenda ko ang proyektong ito sa ibang mga lokal na magsasaka na kilala ko at nakikipagtulungan.)**			✓	
6. The project fits perfectly with the needs of the farm. **(Ang proyekto ay umaangkop nang perpekto sa mga pangangailangan ng bukid.)**			✓	

SUGGESTION AND IMPROVEMENTS

Do you have any specific features or functionalities you would like to see added or modified?
(Mayroon ka bang anumang mga tukoy na tampok o pag-andar na nais mong makita ang idinagdag o binago?)
Answer: Lagyan nga yung MOTOR NYO

USAGE AND ADOPTION

How likely is it for you to do a transition and use/adopt the project?
(Gaano kadalas para sa iyo na gumawa ng isang paglipat at gamitin / itanggitik ang proyekto?)
Answer: KAPAG NAKITA NAMIN NA LALONG LUMAKAS ANG AMON NG TUBIG

BENEFITS AND IMPACT

What are the possible benefits and impacts of this project in your field of work?
(Ano ang mga posibleng benepisyo at epekto ng proyektong ito sa iyong larangan ng trabaho?)
Answer: HINDI NA GAMIN KAILANGAN NG KURYENTE

Thank you for taking the time to complete this survey questionnaire. We greatly value your cooperation, and we are deeply grateful for your time and consideration.

If you have any questions or want to be kept updated regarding this project and/or willing to participate in future research, feel free to contact us on 09303014212 or 09163207552 (Ireh Dawn Cruz) or send an email to irehdawn.cruz@tup.edu.ph or cruz.irehdawn@gmail.com.

R.S.

WATER GUARDEN: WATERWORKS AI SURVEY FORM

Introduction: The students involved in the study need to conduct a survey for the evaluation of different aspects of the technology developed in the research entitled ***"WATERWORKS - AI: DEVELOPMENT OF A SOLAR-POWERED AUTOMATED FERTIGATION SYSTEM WITH IRRIGATION SCHEDULING AND WATER FLOW CONTROL SYSTEM FOR FIELD CROPS UTILIZING DRIP IRRIGATION WITH MOBILE APPLICATION".***

It is expected that the questionnaire will take about 15 minutes to complete. If you consent to participate, your responses will be kept confidential. The information provided will be used solely for the purpose of this research project and only aggregated results will be reported in reputable academic publications. No persons other than my supervisors and I will have access to the information you provide. Your participation is voluntary, and you are free to withdraw consent at any time and to withdraw any unprocessed data you have previously supplied. Upon completion of the research, all questionnaires will be securely stored.
(Inaasahan na ang talatanungan ay aabutin ng 15 minuto upang makumpleto. Kung pumayag kang lumahok, ang iyong mga tugon ay panatilihing kumpidensyal. Ang impormasyong ibinigay ay gagamitin lamang para sa layunin ng proyektong ito ng pananaliksik at ang mga pinagsama-samang mga resulta ay maiulat sa kagalang-galang na mga publikasyong pang-akademiko. Walang ibang tao maliban sa aking mga superbisor at magkakaroon ako ng access sa impormasyong iyong ibinibigay. Ang iyong pakikilahok ay kusang-loob, at malaya kang mag-alis ng pahintulot sa anumang oras at mag-alis ng anumang hindi pa nasuri na data na dati mong naibigay. Kapag natapos ang pananaliksik, ang lahat ng mga talatanungan ay ligtas na maiimbak.)

NAME (PANGALAN): CESAR MANGON	AGE (EDAD): 57
GENDER (KASARIAN): MALE	OCCUPATION (TRABAHO): FARMER

AWARENESS AND FAMILIARITY WITH THE PROJECT

Do you have any prior experience or knowledge about similar technologies?
(Mayroon ka bang naunang karanasan o kaalaman tungkol sa mga katulad na teknolohiya?) *Answer:* HINDI PA

TECHNOLOGY EVALUATION

	STRONGLY DISAGREE	DISAGREE	AGREE	STRONGLY AGREE
IRRIGATION/FERTIGATION SYSTEM				
1. The automated fertigation system is more convenient than the conventional method. **(Ang awtomatikong sistema ng fertigasyon ay mas maginhawa kaysa sa nakasanayan na pamamaraan.)**			✓	
2. The use of solar panels as power source is beneficial to the local farmers. **(Ang paggamit ng mga solar panel bilang mapagkukunan ng kuryente ay kapaki-pakinabang sa mga lokal na magsasaka.)**			✓	
3. The project lessens the cost of maintenance of the irrigation system compared to the previous system used. **(Binabawasan ng proyekto ang gastos ng pagpapanatili ng sistema ng patubig kumpara sa nakaraang sistema na ginamit.)**		✓		
4. The system outputs accurate amount of fertilizer. **(Ang sistema ay naglalabas ng tumpak na halaga ng pataba.)**			✓	
5. The system shows many inconsistencies on it. **(Ang systema ay nagpapakita ng maraming hindi pagkakapare-pareho dito.)**		✓		
6. The system's function increases efficiency on the farmer's job. **(Ang pagpapaandar ng sistema ay nagdaragdag ng kahusayan sa trabaho ng magsasaka.)**			✓	
7. The system lessens the existing farmer's workload. **(Binabawasan ng sistema ang umiiral na trabaho ng magsasaka.)**			✓	
8. The project helps in conserving water using drip irrigation. **(Tumutulong ang proyekto sa pag-titipid ng tubig gamit ang drip na patubig.)**			✓	
9. The reliability of the system is satisfactory. **(Ang pagiging maaasahan ng system ay kasiya-siya.)**			✓	
MOBILE APPLICATION				
1. The project has a user-friendly interface for the mobile application and is very easy to access and control. **(Ang proyekto ay may user-friendly interface para sa mobile application at napakadaling ma-access at kontrolin.)**			✓	
2. The software has all the functions and capabilities I expected it to have. **(Ang software ay may lahat ng mga pag-andar at kakayahan na inaasahan kong magkaroon ito.)**			✓	
3. I can easily add and/or delete irrigation or fertigation schedules. **(Madali akong magdagdag at / o magtanggal ng mga iskedyul ng patubig.)**			✓	
4. The gathered data of the system are very helpful. **(Ang natipon na data ng system ay lubos na kapaki-pakinabang.)**			✓	
OVERALL FEEDBACK				
1. This project is useful to the overall work of the local farmers. **(Ang proyektong ito ay kapaki-pakinabang sa pangkalahatang gawain ng mga lokal na magsasaka.)**			✓	
2. This project gives me satisfaction by its performance. **(Ang proyektong ito ay nagbibigay sa akin ng kasiyahan sa pamamagitan ng paggamap nito.)**			✓	
3. I feel comfortable using this system. **(Kumportable ako sa paggamit ng sistemang ito.**			✓	
3. The project can be used for a long period of time in mind. **(Ang proyekto ay maaaring magamit para sa isang mahabang panahon.)**			✓	
4. Through this project, it lets me widen my technological perspective. **(Sa pamamagitan ng proyektong ito, hinahayaan akong palawakin ang aking pananaw sa teknolohiya. 0**			✓	
5. I will recommend this project to other local farmers I know and work with. **(Irerekumenda ko ang proyektong ito sa iba mga lokal na magsasaka na kilala ko at nakikipagtulungan.)**			✓	
6. The project fits perfectly with the needs of the farm. **(Ang proyekto ay umaangkop nang perpekto sa mga pangangailangan ng bukid.)**			✓	

BENEFITS AND IMPACT

What are the possible benefits and impacts of this project in your field of work?
(Ano ang mga posibleng benepisyo at epekto ng proyektong ito sa iyong larangan ng trabaho?)
Answer: MAS MAPAPADALI AT MAPAPABILIS ANG RAING TRABAHO

SUGGESTION AND IMPROVEMENTS

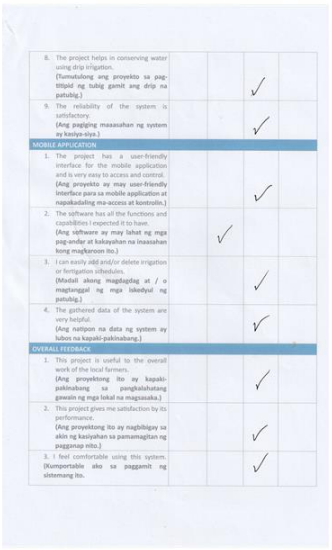
Do you have any specific features or functionalities you would like to see added or modified?
(Mayroon ka bang anumang mga tukoy na tampok o pag-andar na nais mong makita ang idinagdag o binago?)
Answer: PALAKIHIN ANG MOTOR PARA MAS MARAMI ANG NIGA NG TUBIG

USAGE AND ADOPTION

How likely is it for you to do a transition and use/adopt the project?
(Gaano kadalas para sa iyo na gumawa ng isang pagliput at gamitin / itangkilik ang proyekto?)
Answer: HINDI PA GAMAY SA MGAYON NGUNIT KAPAG NAPALAKAN PA NG KUNTO NY POWDE NAMAN

Thank you for taking the time to complete this survey questionnaire. We greatly value your cooperation, and we are deeply grateful for your time and consideration.

If you have any questions or want to be kept updated regarding this project and/or willing to participate in future research, feel free to contact us on 09303014212 or 09163207552 (Jireh Dawn Cruz) or send an email to jirehdawn.cruz@tup.edu.ph or cruz.jirehdawn@gmail.com.



8. The project helps in conserving water using drip irrigation. (Tumutulong ang proyekto sa pag-tiptipid ng tubig gamit ang drip na patubig.)			✓	
9. The reliability of the system is satisfactory. (Ang pagiging maasahan ng system ay kasiya-siya.)			✓	
MOBILE APPLICATION				
1. The project has a user-friendly interface for the mobile application and is very easy to access and control. (Ang proyekto ay may user-friendly interface para sa mobile application at napakadaling ma-access at kontrolin.)			✓	
2. The software has all the functions and capabilities I expected it to have. (Ang software ay may lahat ng mga pag-andar at kakayahan na inaasahan kong magkaroon ito.)		✓		
3. I can easily add and/or delete irrigation or fertigation schedules. (Madali akong magdagdag at / o magtanggal ng mga lakedyul ng patubig.)			✓	
4. The gathered data of the system are very helpful. (Ang natipon na data ng system ay lubos na kapaki-pakinabang.)			✓	
OVERALL FEEDBACK				
1. This project is useful to the overall work of the local farmers. (Ang proyektong ito ay kapaki-pakinabang sa pangkalahatang gawain ng mga lokal na magsasaka.)			✓	
2. This project gives me satisfaction by its performance. (Ang proyektong ito ay nagbibigay sa akin ng kasiyahan sa pamamagitan ng paggana nito.)			✓	
3. I feel comfortable using this system. (Komportable ako sa paggamit ng sistemang ito.			✓	

TECHNOLOGY EVALUATION

	STRONGLY DISAGREE	DISAGREE	AGREE	STRONGLY AGREE
IGATION/FERTIGATION SYSTEM				
1. The automated fertigation system is more convenient than the conventional method. (Ang awtomatikong sistema ng fertigasyon ay mas maginhawa kaysa sa nakasanayan na pamamaraan.)			✓	
2. The use of solar panels as power source is beneficial to the local farmers. (Ang paggamit ng mga solar panel bilang mapagkukunan ng kuryente ay kapaki-pakinabang sa mga lokal na magsasaka.)			✓	
3. The project lessens the cost of maintenance of the irrigation system compared to the previous system used. (Binabawasan ng proyekto ang gastos ng pagpapanatili ng sistema ng patubig kumpara sa nakaraang sistema na ginamit.)			✓	
4. The system outputs accurate amount of fertilizer. (Ang sistema ay naglalabas ng tumpak na halaga ng pataba.)			✓	
5. The system shows many inconsistencies on it. (Ang systema ay nagpapakita ng maraming hindi pagkakapare-pareho dito.)		✓		
6. The system's function increases efficiency on the farmer's job. (Ang pagpapaandar ng sistema ay nagdaragdag ng kahusayan sa trabaho ng magsasaka.)			✓	
7. The system lessens the existing farmer's workload. (Binabawasan ng sistema ang umiiral na trabaho ng magsasaka.)		✓		

WATER GUARDEN: WATERWORKS AI SURVEY FORM

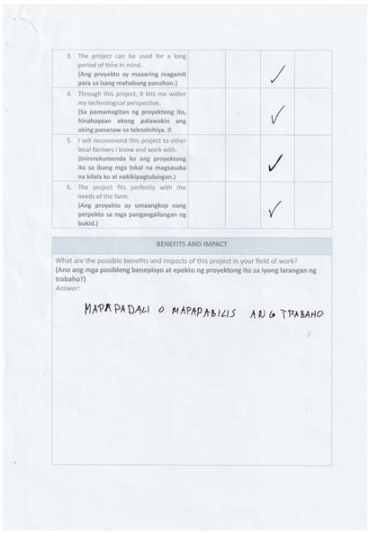
Introduction: The students involved in the study need to conduct a survey for the evaluation of different aspects of the technology developed in the research entitled ***"WATERWORKS - AI: DEVELOPMENT OF A SOLAR-POWERED AUTOMATED FERTIGATION SYSTEM WITH IRRIGATION SCHEDULING AND WATER FLOW CONTROL SYSTEM FOR FIELD CROPS UTILIZING DRIP IRRIGATION WITH MOBILE APPLICATION".***

It is expected that the questionnaire will take about 15 minutes to complete. If you consent to participate, your responses will be kept confidential. The information provided will be used solely for the purpose of this research project and only aggregated results will be reported in reputable academic publications. No persons other than my supervisors and I will have access to the information you provide. Your participation is voluntary, and you are free to withdraw consent at any time and to withdraw any unprocessed data you have previously supplied. Upon completion of the research, all questionnaires will be securely stored.
(Inaasahan na ang talatanungan ay aabutin ng 15 minuto upang makumpleto. Kung pumayag kang lumahok, ang iyong mga tugon ay panatilihing kumpidensyal. Ang impormasyong ibinigay ay gagamitin lamang para sa layunin ng proyektong ito ng pananaliksik at ang mga pinagsama-samang mga resulta ay maiulat sa kagalang-galang na mga publikasyong pang-akademiko. Walang ibang tao maliban sa aking mga superbisor at magkakaroon ako ng access sa impormasyong iyong ibinibigay. Ang iyong pakikiisahok ay kusang-loob, at malaya kang mag-alis ng pahintulot sa anumang oras at mag-alis ng anumang hindi pa nasuri na data na dati mong naibigay. Kapag natapos ang pananaliksik, ang lahat ng mga talatanungan ay ligtas na maiimbak.)

NAME (PANGALAN): GRACIANO CRUZ	AGE (EDAD): 56
GENDER (KASARIAN): M	OCCUPATION (TRABAHO): DRIVER

AWARENESS AND FAMILIARITY WITH THE PROJECT

Do you have any prior experience or knowledge about similar technologies? **(Mayroon ka bang naunang karanasan o kaalaman tungkol sa mga katulad na teknolohiya?)** *Answer:* NO

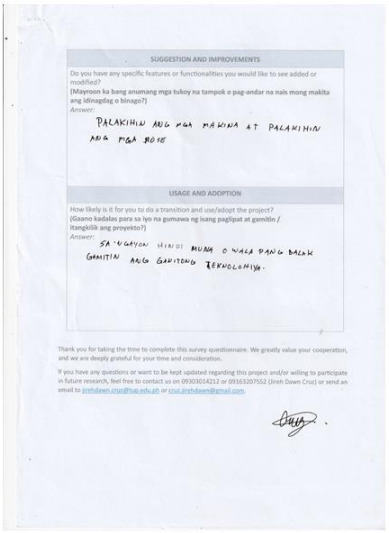


3. The project can be used for a long period of time in mind. (Ang proyekto ay maaaring magamit para sa isang mahabang panahon.)			✓	
4. Through this project, it lets me widen my technological perspective. (Sa pamamagitan ng proyektong ito, hinahayaan akong palawakin ang aking pananaw sa teknolohiya. 0			✓	
5. I will recommend this project to other local farmers I know and work with. (Inirerekumenda ko ang proyektong ito sa ibang mga lokal na magsasaka na kilala ko at nakikipagtulungan.)			✓	
6. The project fits perfectly with the needs of the farm. (Ang proyekto ay umaangkop nang perpekto sa mga pangangailangan ng bukid.)			✓	

BENEFITS AND IMPACT

What are the possible benefits and impacts of this project in your field of work? **(Ano ang mga posibleng benepisyo at epekto ng proyektong ito sa iyong larangan ng trabaho?)**
Answer:

MAPAPADALI O MAPAPABILIS ANG TRABAHO



SUGGESTION AND IMPROVEMENTS

Do you have any specific features or functionalities you would like to see added or modified? **(Mayroon ka bang anumang mga tukoy na tampok o pag-andar na nais mong makita ang idinagdag o binago?)**
Answer:

PALAKIHIN ANG MGA MAKINA AT PALAKIHIN ANG MGA BOTE

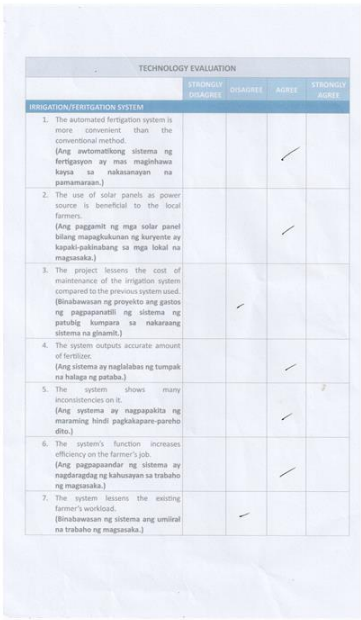
USAGE AND ADOPTION

How likely is it for you to do a transition and use/adopt the project? **(Gaano kadalas para sa iyo na gumawa ng isang pagliput at gamitin / itangkilik ang proyekto?)**
Answer:

SA KASAYAN HINDI MUNA O WALA PANG BALAK GAMITIN ANG GANITONG TEKNOLOHIYA.

Thank you for taking the time to complete this survey questionnaire. We greatly value your cooperation, and we are deeply grateful for your time and consideration.

If you have any questions or want to be kept updated regarding this project and/or willing to participate in future research, feel free to contact us on 09303014212 or 09163207552 (Ireh Dawn Cruz) or send an email to irehdawn.cruz@tup.edu.ph or cruz.irehdawn@gmail.com.



TECHNOLOGY EVALUATION	STRONGLY DISAGREE	DISAGREE	AGREE	STRONGLY AGREE
IRRIGATION/FERITGATION SYSTEM				
1. The automated fertigation system is more convenient than the conventional method. **(Ang awtomatikong sistema ng fertigasyon ay mas maginhawa kaysa sa nakasanayan na pamamaraan.)**			✓	
2. The use of solar panels as power source is beneficial to the local farmers. **(Ang paggamit ng mga solar panel bilang mapagkukunan ng kuryente ay kapaki-pakinabang sa mga lokal na magsasaka.)**			✓	
3. The project lessens the cost of maintenance of the irrigation system compared to the previous system used. **(Binabawasan ng proyekto ang gastos ng pagpapanatili ng sistema ng patubig kumpara sa nakaraang sistema na ginamit.)**		✓		
4. The system outputs accurate amount of fertilizer. **(Ang sistema ay naglalabas ng tumpak na halaga ng pataba.)**			✓	
5. The system shows many inconsistencies on it. **(Ang systema ay nagpapakita ng maraming hindi pagkakapare-pareho dito.)**			✓	
6. The system's function increases efficiency on the farmer's job. **(Ang pagpapaandar ng sistema ay nagdaragdag ng kahusayan sa trabaho ng magsasaka.)**			✓	
7. The system lessens the existing farmer's workload. **(Binabawasan ng sistema ang umiiral na trabaho ng magsasaka.)**		✓		

WATER GUARDEN: WATERWORKS AI SURVEY FORM

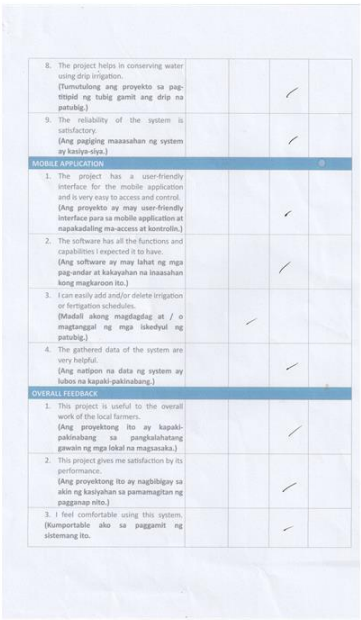
Introduction: The students involved in the study need to conduct a survey for the evaluation of different aspects of the technology developed in the research entitled ***"WATERWORKS - AI: DEVELOPMENT OF A SOLAR-POWERED AUTOMATED FERTIGATION SYSTEM WITH IRRIGATION SCHEDULING AND WATER FLOW CONTROL SYSTEM FOR FIELD CROPS UTILIZING DRIP IRRIGATION WITH MOBILE APPLICATION".***

It is expected that the questionnaire will take about 15 minutes to complete. If you consent to participate, your responses will be kept confidential. The information provided will be used solely for the purpose of this research project and only aggregated results will be reported in reputable academic publications. No persons other than my supervisors and I will have access to the information you provide. Your participation is voluntary, and you are free to withdraw consent at any time and to withdraw any unprocessed data you have previously supplied. Upon completion of the research, all questionnaires will be securely stored.
(Inaasahan na ang talatanungan ay aabutin ng 15 minuto upang makumpleto. Kung pumayag kang lumahok, ang iyong mga tugon ay panatilihing kumpidensyal. Ang impormasyong ibinigay ay gagamitin lamang para sa layunin ng proyektong ito ng pananaliksik at ang mga pinagsama-samang mga resulta ay maiulat sa kagalang-galang na mga publikasyong pang-akademiko. Walang ibang tao maliban sa aking mga superbisor at magkakaroon ako ng access sa impormasyong iyong ibinibigay. Ang iyong pakikilahok ay kusang-loob, at malaya kang mag-alis ng pahintulot sa anumang oras at mag-alis ng anumang hindi pa nasuri na data na dati mong naibigay. Kapag natapos ang pananaliksik, ang lahat ng mga talatanungan ay ligtas na maiimbak.)

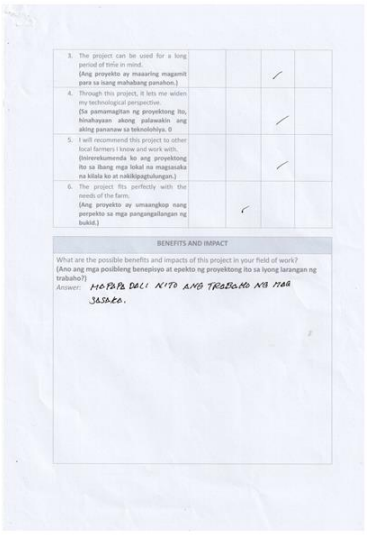
NAME (PANGALAN): ALLENARDO MANGALILI	AGE (EDAD): 40
GENDER (KASARIAN): MALE	OCCUPATION (TRABAHO): DRIVER

AWARENESS AND FAMILIARITY WITH THE PROJECT

Do you have any prior experience or knowledge about similar technologies?
(Mayroon ka bang naunang karanasan o kaalaman tungkol sa mga katulad na teknolohiya?) *Answer:* WALA



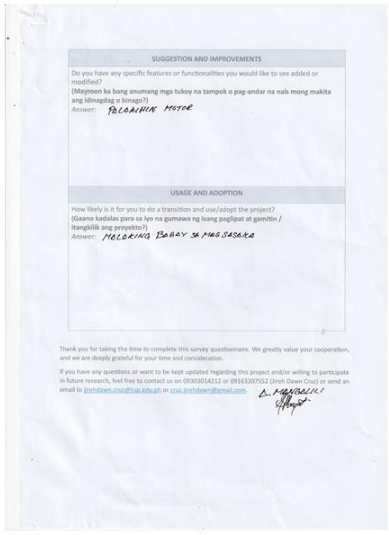
8. The project helps in conserving water using drip irrigation. **(Tumutulong ang proyekto sa pag-titipid ng tubig gamit ang drip na patubig.)**			✓	
9. The reliability of the system is satisfactory. **(Ang pagiging maaasahan ng system ay kasiya-siya.)**			✓	
MOBILE APPLICATION				
1. The project has a user-friendly interface for the mobile application and is very easy to access and control. **(Ang proyekto ay may user-friendly interface para sa mobile application at napakadaling ma-access at kontrolin.)**			✓	
2. The software has all the functions and capabilities I expected it to have. **(Ang software ay may lahat ng mga pag-andar at kakayahan na inaasahan kong magkaroon ito.)**			✓	
3. I can easily add and/or delete irrigation or fertigation schedules. **(Madali akong magdagdag at / o magtanggal ng mga iskedyul ng patubig.)**		✓		
4. The gathered data of the system are very helpful. **(Ang natipon na data ng system ay lubos na kapaki-pakinabang.)**			✓	
OVERALL FEEDBACK				
1. This project is useful to the overall work of the local farmers. **(Ang proyektong ito ay kapaki-pakinabang sa pangkalahatang gawain ng mga lokal na magsasaka.)**			✓	
2. This project gives me satisfaction by its performance. **(Ang proyektong ito ay nagbibigay sa akin ng kasiyahan sa pamamagitan ng pagganap nito.)**			✓	
3. I feel comfortable using this system. **(Kumportable ako sa paggamit ng sistemang ito.**			✓	



3. The project can be used for a long period of time in mind. **(Ang proyekto ay maaaring magamit para sa isang mahabang panahon.)**			✓	
4. Through this project, it lets me widen my technological perspective. **(Sa pamamagitan ng proyektong ito, hinahayaan akong palawakin ang aking pananaw sa teknolohiya. 0**			✓	
5. I will recommend this project to other local farmers I know and work with. **(Inirerekumenda ko ang proyektong ito sa iba ng mga lokal na magsasaka na kilala ko at nakikipagtulungan.)**			✓	
6. The project fits perfectly with the needs of the farm. **(Ang proyekto ay umaangkop nang perpekto sa mga pangangailangan ng bukid.)**		✓		

BENEFITS AND IMPACT

What are the possible benefits and impacts of this project in your field of work?
(Ano ang mga posibleng benepisyo at epekto ng proyektong ito sa iyong larangan ng trabaho?)
Answer: MAPAPA DALI NITO ANG TRABAHO NG MAG SASAKA.



SUGGESTION AND IMPROVEMENTS

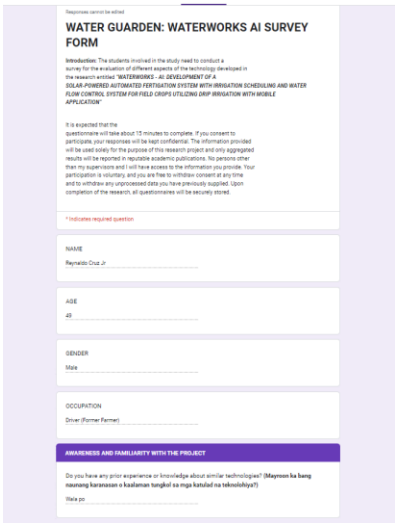
Do you have any specific features or functionalities you would like to see added or modified?
(Mayroon ka bang anumang mga tukoy na tampok o pag-andar na nais mong makita ang idinagdag o binago?)
Answer: PALAKIHIN MOTOR

USAGE AND ADOPTION

How likely is it for you to do a transition and use/adopt the project?
(Gaano kadalas para sa iyo na gumawa ng isang paglipat at gamitin / itangkilik ang proyekto?)
Answer: MALORING BABAY SA MGA SASAKA

Thank you for taking the time to complete this survey questionnaire. We greatly value your cooperation, and we are deeply grateful for your time and consideration.

If you have any questions or want to be kept updated regarding this project and/or willing to participate in future research, feel free to contact us on 09303014212 or 09163207552 (Jireh Dawn Cruz) or send an email to jirehdawn.cruz@tup.edu.ph or cruz.jirehdawn@gmail.com.



WATER GUARDEN: WATERWORKS AI SURVEY FORM

Introduction: The students involved in the study need to conduct a survey for the evaluation of different aspects of the technology developed in the research entitled "**WATERWORKS - AI: DEVELOPMENT OF A SOLAR-POWERED AUTOMATED FERTIGATION SYSTEM WITH IRRIGATION SCHEDULING AND WATER FLOW CONTROL SYSTEM FOR FIELD CROPS UTILIZING DRIP IRRIGATION WITH MOBILE APPLICATION**"

It is expected that the questionnaire will take about 15 minutes to complete. If you consent to participate, your responses will be kept confidential. The information provided will be used solely for the purpose of this research project and only aggregated results will be reported in reputable academic publications. No persons other than my supervisors and I will have access to the information you provide. Your participation is voluntary, and you are free to withdraw consent at any time and to withdraw any unprocessed data you have previously supplied. Upon completion of the research, all questionnaires will be securely stored.

* Indicates required question

NAME
Reynaldo Cruz Jr

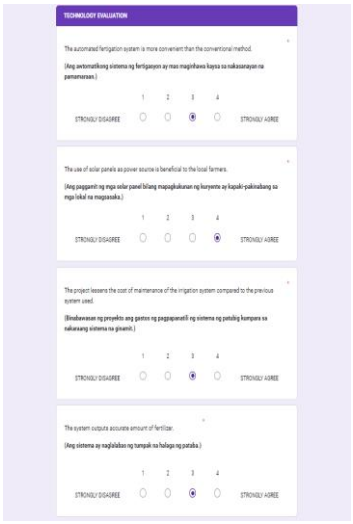
AGE
49

GENDER
Male

OCCUPATION
Driver (Former Farmer)

AWARENESS AND FAMILIARITY WITH THE PROJECT

Do you have any prior experience or knowledge about similar technologies? (Mayroon ka bang naunang karanasan o kaalaman tungkol sa mga katulad na teknolohiya?)
Wala po



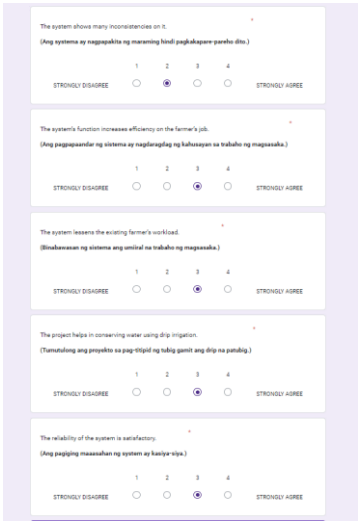
TECHNOLOGY EVALUATION

The automated fertigation system is more convenient than the conventional method. *
(Ang awtomatikong sistema ng fertigasyon ay mas maginhawa kaysa sa nakasanayan na pamamaraan.)
1 2 3 4
STRONGLY DISAGREE ○ ○ ◉ ○ STRONGLY AGREE

The use of solar panels as power source is beneficial to the local farmers. *
(Ang paggamit ng mga solar panel bilang mapagkukunan ng kuryente ay kapaki-pakinabang sa mga lokal na magsasaka.)
1 2 3 4
STRONGLY DISAGREE ○ ○ ○ ◉ STRONGLY AGREE

The project lessens the cost of maintenance of the irrigation system compared to the previous system used. *
(Binabawasan ng proyekto ang gastos ng pagpapanatili ng sistema ng patubig kumpara sa nakaraang sistema na ginamit.)
1 2 3 4
STRONGLY DISAGREE ○ ○ ◉ ○ STRONGLY AGREE

The system outputs accurate amount of fertilizer. *
(Ang sistema ay naglalabas ng tumpak na halaga ng pataba.)
1 2 3 4
STRONGLY DISAGREE ○ ○ ◉ ○ STRONGLY AGREE



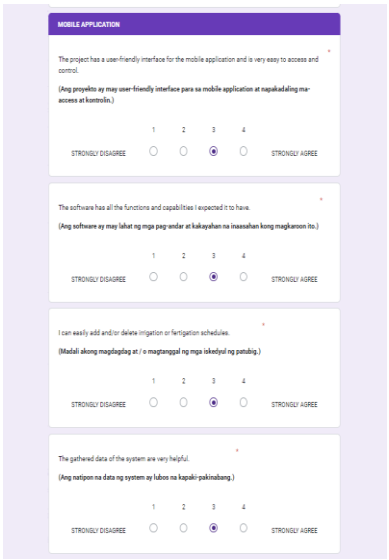
The system shows many inconsistencies on it. *
(Ang systema ay nagpapakita ng maraming hindi pagkakapare-pareho dito.)
1 2 3 4
STRONGLY DISAGREE ○ ◉ ○ ○ STRONGLY AGREE

The system's function increases efficiency on the farmer's job. *
(Ang pagpapaandar ng sistema ay nagdaragdag ng kahusayan sa trabaho ng magsasaka.)
1 2 3 4
STRONGLY DISAGREE ○ ○ ◉ ○ STRONGLY AGREE

The system lessens the existing farmer's workload. *
(Binabawasan ng sistema ang umiiral na trabaho ng magsasaka.)
1 2 3 4
STRONGLY DISAGREE ○ ○ ◉ ○ STRONGLY AGREE

The project helps in conserving water using drip irrigation. *
(Tumutulong ang proyekto sa pag-titipid ng tubig gamit ang drip na patubig.)
1 2 3 4
STRONGLY DISAGREE ○ ○ ◉ ○ STRONGLY AGREE

The reliability of the system is satisfactory. *
(Ang pagiging maaasahan ng system ay kasiya-siya.)
1 2 3 4
STRONGLY DISAGREE ○ ○ ◉ ○ STRONGLY AGREE



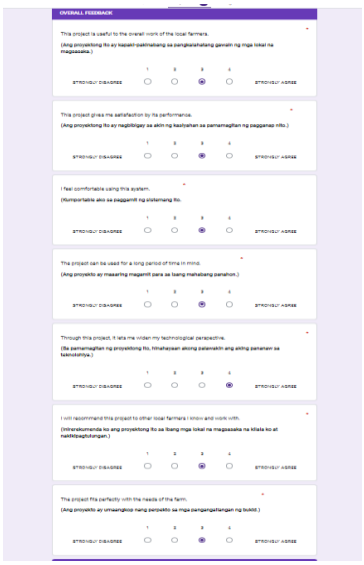
MOBILE APPLICATION

The project has a user-friendly interface for the mobile application and is very easy to access and control. *
(Ang proyekto ay may user-friendly interface para sa mobile application at napakadaling ma-access at kontrolin.)
1 2 3 4
STRONGLY DISAGREE ○ ○ ◉ ○ STRONGLY AGREE

The software has all the functions and capabilities I expected it to have. *
(Ang software ay may lahat ng mga pag-andar at kakayahan na inaasahan kong magkaroon ito.)
1 2 3 4
STRONGLY DISAGREE ○ ○ ◉ ○ STRONGLY AGREE

I can easily add and/or delete irrigation or fertigation schedules. *
(Madali akong magdagdag at / o magtanggal ng mga iskedyul ng patubig.)
1 2 3 4
STRONGLY DISAGREE ○ ○ ◉ ○ STRONGLY AGREE

The gathered data of the system are very helpful. *
(Ang natipon na data ng system ay lubos na kapaki-pakinabang.)
1 2 3 4
STRONGLY DISAGREE ○ ○ ◉ ○ STRONGLY AGREE



OVERALL FEEDBACK

This project is useful to the overall work of the local farmers. *
(Ang proyektong ito ay kapaki-pakinabang sa pangkalahatang gawain ng mga lokal na magsasaka.)
1 2 3 4
STRONGLY DISAGREE ○ ○ ◉ ○ STRONGLY AGREE

This project gives me satisfaction by its performance. *
(Ang proyektong ito ay nagbibigay sa akin ng kasiyahan sa pamamagitan ng pagganap nito.)
1 2 3 4
STRONGLY DISAGREE ○ ○ ◉ ○ STRONGLY AGREE

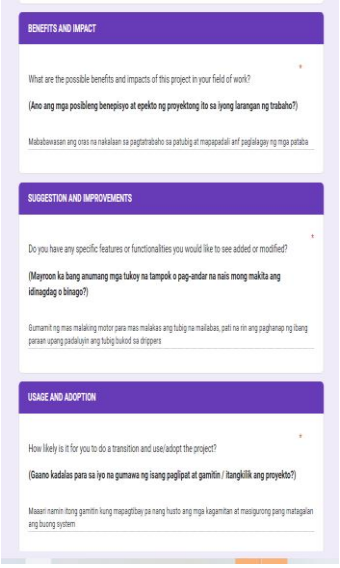
I feel comfortable using this system. *
(Komportable ako sa paggamit ng sistemang ito.
1 2 3 4
STRONGLY DISAGREE ○ ○ ◉ ○ STRONGLY AGREE

The project can be used for a long period of time in mind. *
(Ang proyekto ay maaaring magamit para sa isang mahabang panahon.)
1 2 3 4
STRONGLY DISAGREE ○ ○ ◉ ○ STRONGLY AGREE

Through this project, it lets me widen my technological perspective. *
(Sa pamamagitan ng proyektong ito, hinahayaan akong palawakin ang aking pananaw sa teknolohiya.)
1 2 3 4
STRONGLY DISAGREE ○ ○ ○ ◉ STRONGLY AGREE

I will recommend this project to other local farmers I know and work with. *
(Irirekomenda ko ang proyektong ito sa iba ng mga lokal na magsasaka na kilala ko at nakikipagtulungan.)
1 2 3 4
STRONGLY DISAGREE ○ ○ ◉ ○ STRONGLY AGREE

The project fits perfectly with the needs of the farm. *
(Ang proyekto ay umaangkop nang perpekto sa mga pangangailangan ng bukid.)
1 2 3 4
STRONGLY DISAGREE ○ ○ ◉ ○ STRONGLY AGREE



BENEFITS AND IMPACT

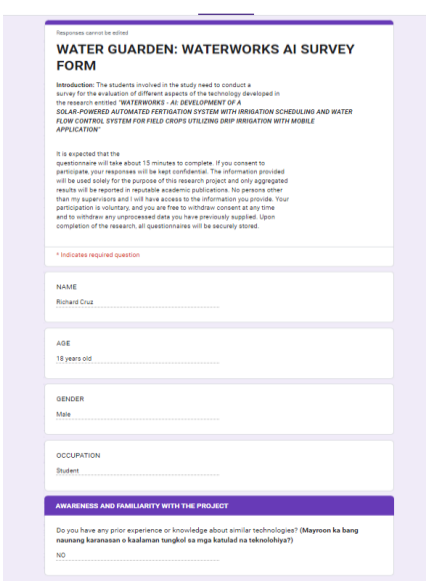
What are the possible benefits and impacts of this project in your field of work? *
(Ano ang mga posibleng benepisyo at epekto ng proyektong ito sa iyong larangan ng trabaho?)
Mababawasan ang oras na nakalaan sa pagtratrabaho sa patubig at magapatali ang paglalagay ng mga pataba

SUGGESTION AND IMPROVEMENTS

Do you have any specific features or functionalities you would like to see added or modified? *
(Mayroon ka bang anumang mga tukoy na tampok o pag-andar na nais mong makita ang idinagdag o binago?)
Gumamit ng mas malaking motor para mas malakas ang tubig na mailabas, pati na rin ang paghanap ng ibang paraan upang padaluyin ang tubig bukod sa drippers

USAGE AND ADOPTION

How likely is it for you to do a transition and use/adopt the project? *
(Gaano kadalas para sa iyo na gumawa ng isang paglipat at gamitin / itangkilik ang proyekto?)
Maaari namin itong gamitin kung mapagtibay pa nang husto ang mga kagamitan at masigurong pang matagalan ang buong system



Responses cannot be edited

WATER GUARDEN: WATERWORKS AI SURVEY FORM

Introduction: The students involved in the study need to conduct a survey for the evaluation of different aspects of the technology developed in the research entitled "***WATERWORKS - AI: DEVELOPMENT OF A SOLAR-POWERED AUTOMATED FERTIGATION SYSTEM WITH IRRIGATION SCHEDULING AND WATER FLOW CONTROL SYSTEM FOR FIELD CROPS UTILIZING DRIP IRRIGATION WITH MOBILE APPLICATION***"

It is expected that the questionnaire will take about 15 minutes to complete. If you consent to participate, your responses will be kept confidential. The information provided will be used solely for the purpose of this research project and only aggregated results will be reported in reputable academic publications. No persons other than my supervisors and I will have access to the information you provide. Your participation is voluntary, and you are free to withdraw consent at any time and to withdraw any unprocessed data you have previously supplied. Upon completion of the research, all questionnaires will be securely stored.

* Indicates required question

NAME
Richard Cruz

AGE
18 years old

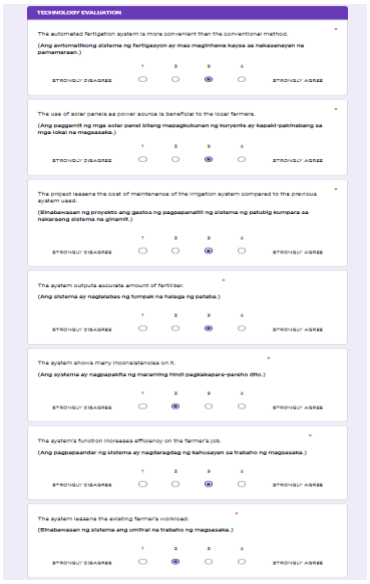
GENDER
Male

OCCUPATION
Student

AWARENESS AND FAMILIARITY WITH THE PROJECT

Do you have any prior experience or knowledge about similar technologies? **(Mayroon ka bang naunang karanasan o kaalaman tungkol sa mga katulad na teknolohiya?)**

NO



TECHNOLOGY EVALUATION

The automated fertigation system is more convenient than the conventional method.
(Ang awtomatikong sistema ng fertigasyon ay mas maginhawa kaysa sa nakasanayan na pamamaraan.)

The use of solar panels as power source is beneficial to the local farmers.
(Ang paggamit ng mga solar panel bilang mapagkukunan ng kuryente ay kapaki-pakinabang sa mga lokal na magsasaka.)

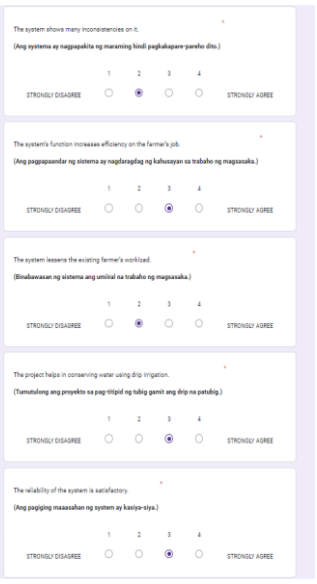
The project lessens the cost of maintenance of the irrigation system compared to the previous system used.
(Binabawasan ng proyekto ang gastos ng pagpapanatili ng sistema ng patubig kumpara sa nakaraang sistema na ginamit.)

The system outputs accurate amount of fertilizer.
(Ang sistema ay naglalabas ng tumpak na halaga ng pataba.)

The system shows many inconsistencies on it.
(Ang sistema ay nagpapakita ng maraming hindi pagkakapare-pareho dito.)

The system's function increases efficiency on the farmer's job.
(Ang pagpapaandar ng sistema ay nagdaragdag ng kahusayan sa trabaho ng magsasaka.)

The system lessens the existing farmer's workload.
(Binabawasan ng sistema ang umiiral na trabaho ng magsasaka.)



The system shows many inconsistencies on it.
(Ang sistema ay nagpapakita ng maraming hindi pagkakapare-pareho dito.)

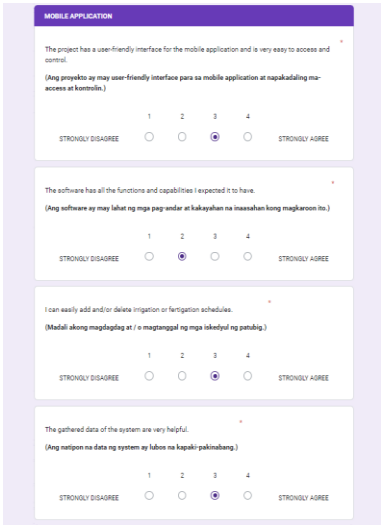
The system's function increases efficiency on the farmer's job.
(Ang pagpapaandar ng sistema ay nagdaragdag ng kahusayan sa trabaho ng magsasaka.)

The system lessens the existing farmer's workload.
(Binabawasan ng sistema ang umiiral na trabaho ng magsasaka.)

The project helps in conserving water using drip irrigation.
(Tumutulong ang proyekto sa pag-tipid ng tubig gamit ang drip na patubig.)

The reliability of the system is satisfactory.
(Ang pagiging maaasahan ng system ay kasiya-siya.)

STRONGLY DISAGREE 1 2 3 4 STRONGLY AGREE



MOBILE APPLICATION

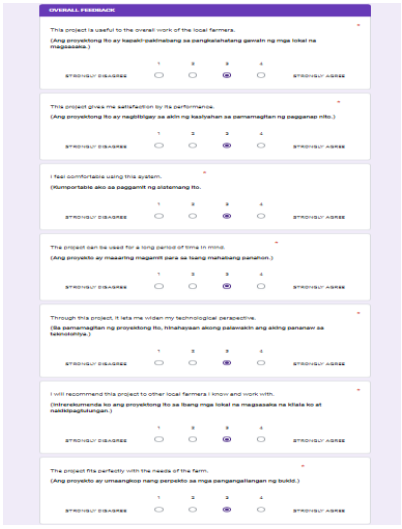
The project has a user-friendly interface for the mobile application and is very easy to access and control.
(Ang proyekto ay may user-friendly interface para sa mobile application at napakadaling ma-access at kontrolin.)

The software has all the functions and capabilities I expected it to have.
(Ang software ay may lahat ng mga pag-andar at kakayahan na inaasahan kong magkaroon ito.)

I can easily add and/or delete irrigation or fertigation schedules.
(Madali akong magdagdag at / o magtanggal ng mga iskedyul ng patubig.)

The gathered data of the system are very helpful.
(Ang natipon na data ng system ay lubos na kapaki-pakinabang.)

STRONGLY DISAGREE 1 2 3 4 STRONGLY AGREE



OVERALL FEEDBACK

This project is useful to the overall work of the local farmers.
(Ang proyektong ito ay kapaki-pakinabang sa pangkalahatang gawain ng mga lokal na magsasaka.)

This project gives me satisfaction by its performance.
(Ang proyektong ito ay nagbibigay sa akin ng kasiyahan sa pamamagitan ng pagganap nito.)

I feel comfortable using this system.
(Komportable ako sa paggamit ng sistemang ito.

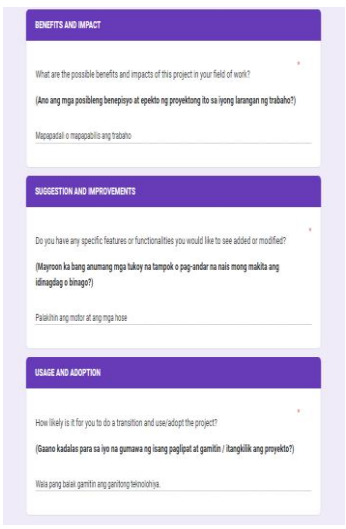
The project can be used for a long period of time in mind.
(Ang proyekto ay maaaring magamit para sa isang mahabang panahon.)

Through this project, it lets me widen my technological perspective.
(Sa pamamagitan ng proyektong ito, hinahayaan akong palawakin ang aking pananaw sa teknolohiya.)

I will recommend this project to other local farmers I know and work with.
(Irerekomenda ko ang proyektong ito sa ibang mga lokal na magsasaka na kilala ko at nakikipagtulungan.)

The project fits perfectly with the needs of the farm.
(Ang proyekto ay umaangkop nang perpekto sa mga pangangailangan ng bukid.)

STRONGLY DISAGREE 1 2 3 4 STRONGLY AGREE



BENEFITS AND IMPACT

What are the possible benefits and impacts of this project in your field of work?
(Ano ang mga posibleng benepisyo at epekto ng proyektong ito sa iyong larangan ng trabaho?)

Mapapadali o mapapabilis ang trabaho

SUGGESTION AND IMPROVEMENTS

Do you have any specific features or functionalities you would like to see added or modified?
(Mayroon ka bang anumang mga tuksy na tampok o pag-andar na nais mong makita ang idinagdag o binago?)

Palakihin ang motor at ang mga hose

USAGE AND ADOPTION

How likely is it for you to do a transition and use/adopt the project?
(Gaano kadalas para sa iyo na gumawa ng isang paglipat at gamitin / itangkilik ang proyekto?)

Wala pang balak gamitin ang panitong teknolohiya.

ANNEX IV
USER MANUAL

Chapter 1 – Introduction

1.1. Overview

The WaterWorks - AI is a solar-powered automated fertigation system with irrigation scheduling and water flow control system for field crops using a microcontroller, solenoid valves, and water-related sensors. It utilizes drip irrigation for the precision and efficiency of delivering water and fertilizers directly to the roots of plants.

The system is designed to reduce water consumption and prevent over-irrigation by smartly monitoring the water flow rate of the system and applying an optimal quantity of fertilizer for field crops by adjusting the flow rate and water pressure of the system. It also utilizes an android mobile application as a controller for the system.

1.2. System Requirements

The WaterWorks - AI utilizes a partnered android mobile application that serves as a controller for the Irrigation/Fertigation scheduling of the system as well as the monitoring of the different water-related sensors in the system. Below are the requirements needed to optimally use the WaterWorks - AI system:

- An android mobile phone using an operating system of android version 9.0 or higher.
- Installed the WaterWorks - AI mobile application
- Stable internet connection
- Registered user account for the mobile application

Chapter 2 – Getting Started

4.1. Hardware

The hardware components of the WaterWorks - AI comprise of a water source system, a control system, and a distribution system. The water source system consists of a water motor pump that is connected to a water source, a water storage

container for storing water, PVC pipes, and an ultrasonic sensor for automatically detecting the water level inside the water storage container.

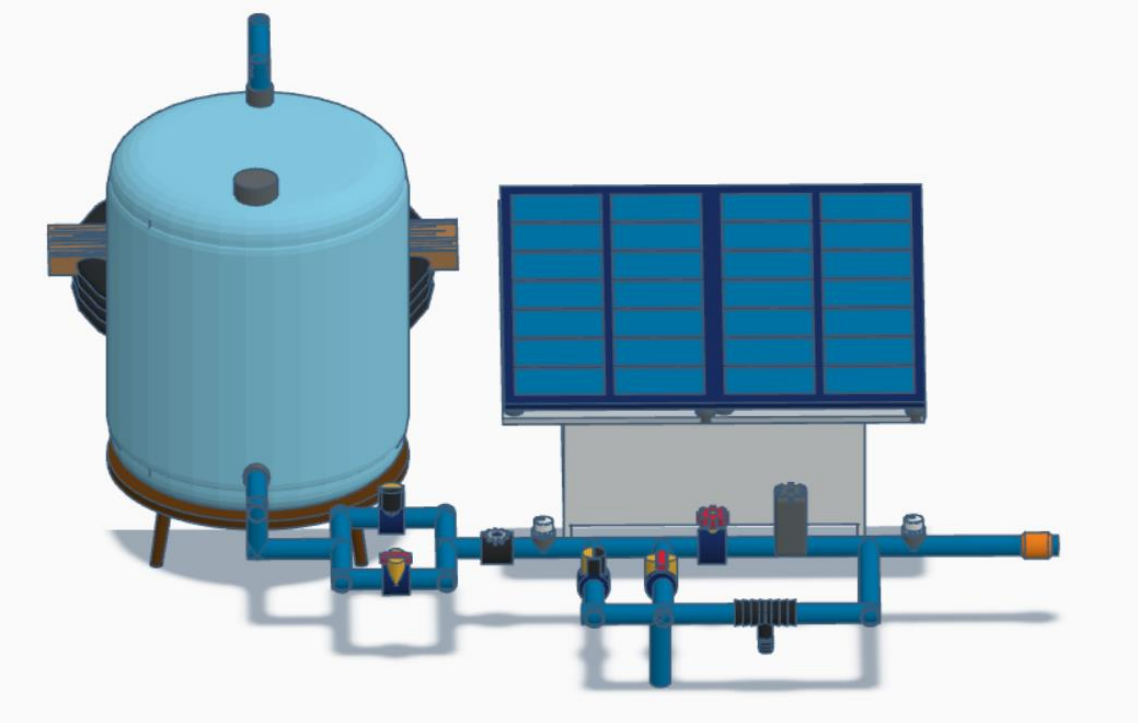


Figure 2.1. Full System Setup Design

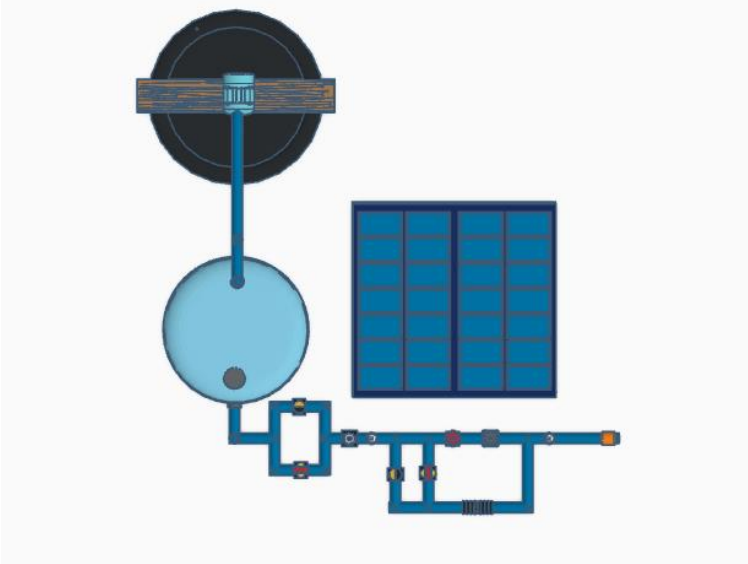


Figure 2.2. System Top-view

The control system utilizes solar panels connected to a battery as a power source of the overall system. The main control circuit is included in this system which is responsible for monitoring the overall process and sending information and instructions to the different electronic components of the overall system.

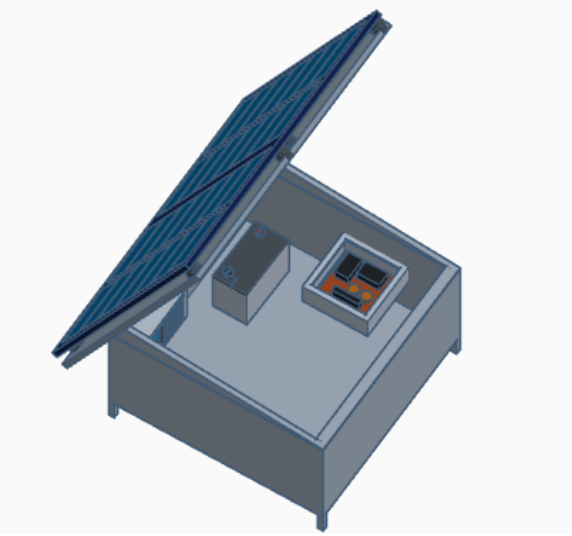


Figure 2.3. Housing Design of the Control System

Lastly, the distribution system utilizes a venturi fertilizer injector, manual ball valves and gate valve, and different electronic components such as solenoid valves, water flow sensor, water pressure sensors, and a stepper-controlled globe valve for the distribution of water and fertilizer. It is modeled after a standard bypass assembly setup which reduces the pressure of the flow of water in the outlet of the system which is essential to the activation of the venturi fertilizer injector.

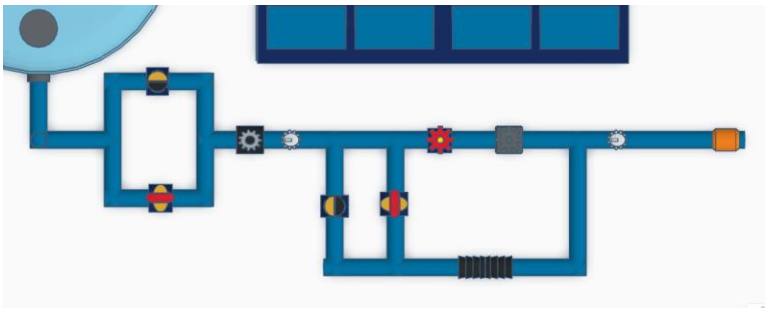


Figure 2.4. Design of the Distribution System

4.2. Circuit Diagram

The circuit diagram for the automated fertigation system incorporates several essential components. The system starts with solar panels that harness sunlight to generate electrical power, which is then stored in a battery. Sensors such as an ultrasonic sensor, water flow sensor, and water pressure sensors are integrated into the circuit to monitor the water level and water flow rates. These sensors provide valuable data to the system. The system utilizes solenoid valves and a stepper-controlled globe valve for controlling the flow of water during an irrigation or fertigation process. The entire system is designed to operate autonomously utilizing a microcontroller, with the solar panels charging the battery and providing power to the sensors and solenoid valves. This circuit diagram for the overall system is shown in the figure below.

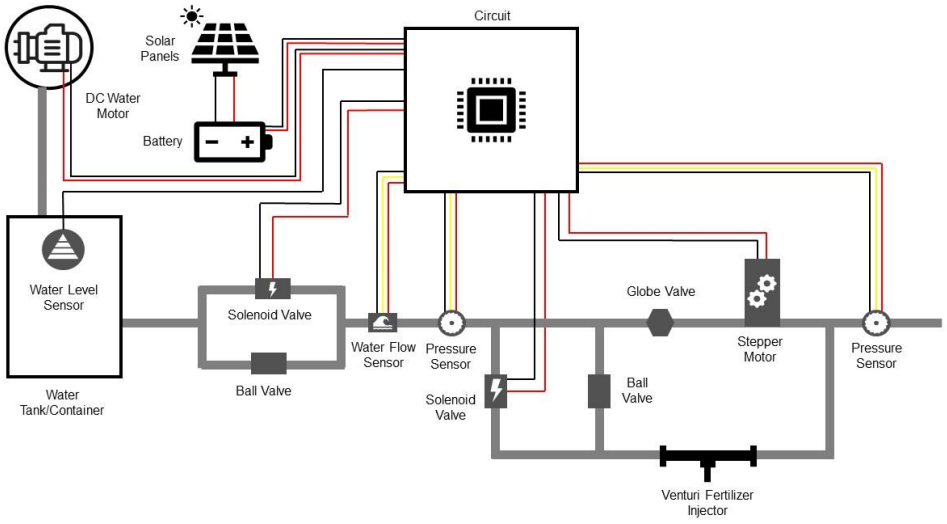


Figure 2.5. Overall System Diagram

A battery will be used as the main source for power distribution of the system and it will be charged using solar energy by utilizing solar panels and a solar charge controller.

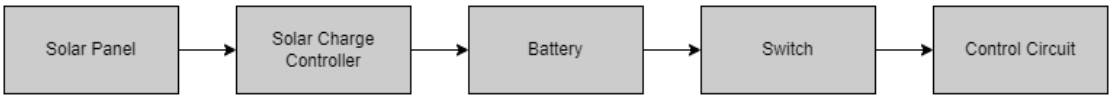


Figure 2.6. Power Distribution Diagram

The control circuit houses the different components and connections used by the system. It includes the Wemos D1 R32 ESP32 microcontroller, which is the main processor of the system, and is connected to the battery which serves as the power supply. The battery is also connected to both the buck converter and the relay modules for powering the different components of the system. Different GPIO pins of the ESP32 microcontroller are utilized for controlling the relay modules and for collecting the data gathered from the sensors.

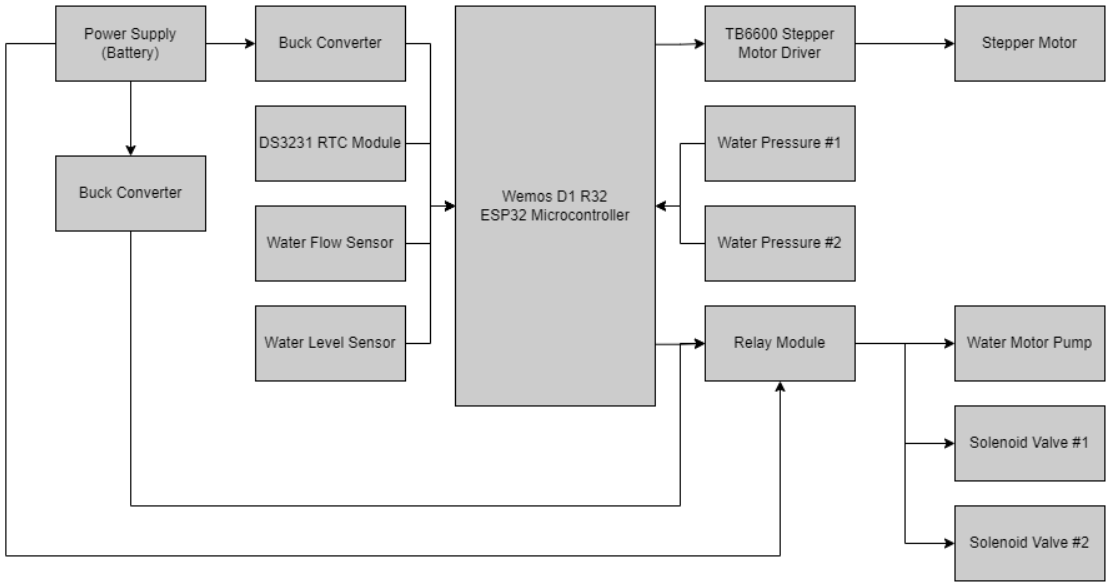


Figure 2.7. Control Circuit Diagram

Chapter 3 – User Interface

3.1. Login Page

The mobile application requires the user to provide user identification and authentication by entering a registered user account credential in the text fields. The layout of the login page utilizes a blue gradient background and it includes the logo and name of the team that created the WaterWorks - AI, it also includes some text input fields for the username and password and a login push button.

Figure 3.1. Login Page

3.2. Dashboard

The dashboard page of the application is a navigation menu that consists of multiple CardView widgets of the different features of the application. The layout of the dashboard utilizes the same theme from the login page and includes six CardView widgets for the Schedule, Monitoring, Upcoming Activities, Previous Activities, Logout, and About Us features of the mobile application.

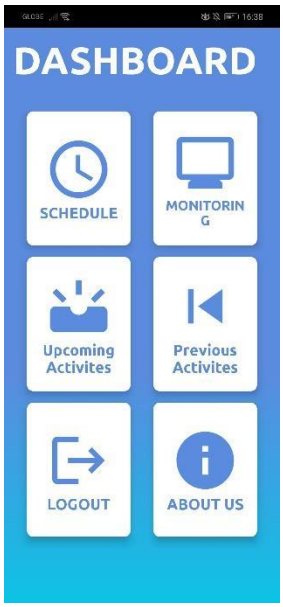


Figure 3.2. Dashboard Page

3.3. Scheduling

The schedule option from the dashboard will show the scheduling selection page which let users choose from two options for which process to proceed with which can either be Irrigation or Fertigation.

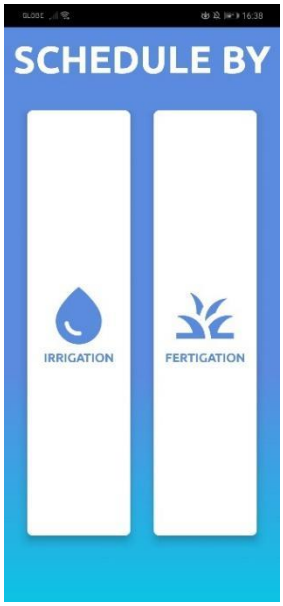


Figure 3.3. Scheduling Selection Page

After choosing which process to use for scheduling, the users will then be directed to either the irrigation or the fertigation scheduling page which have similar layout and features. Each page includes two push button for opening the date picker interface and for the time picker interface. The scheduling layout of the application allows users to set both the date and time for their tasks in a seamless and intuitive manner. An image button is also included in each page for sending the date and time information to the database of the WaterWorks - AI system.

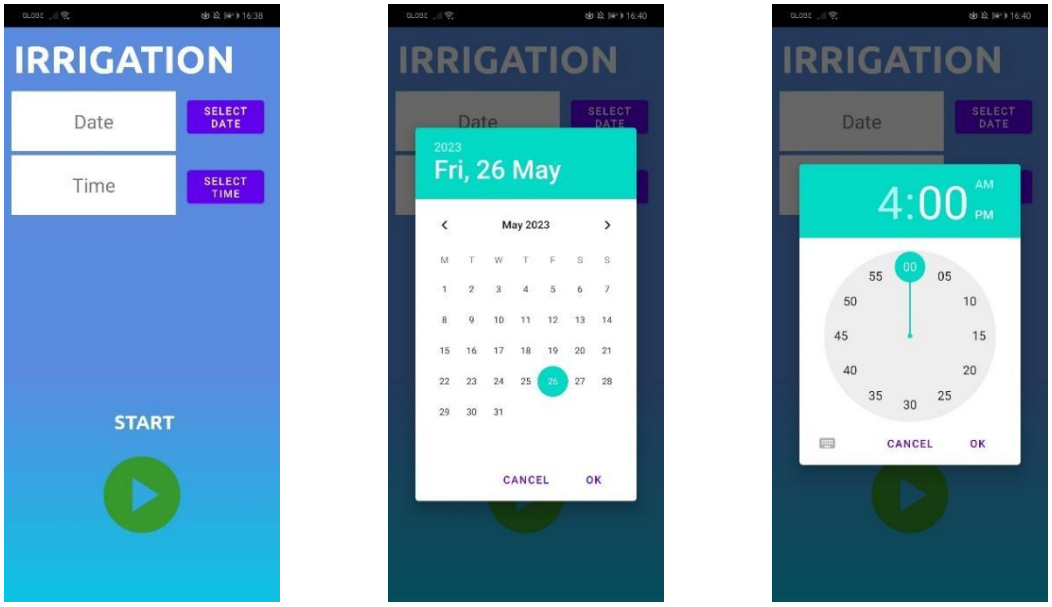


Figure 3.4. Irrigation Scheduling Page

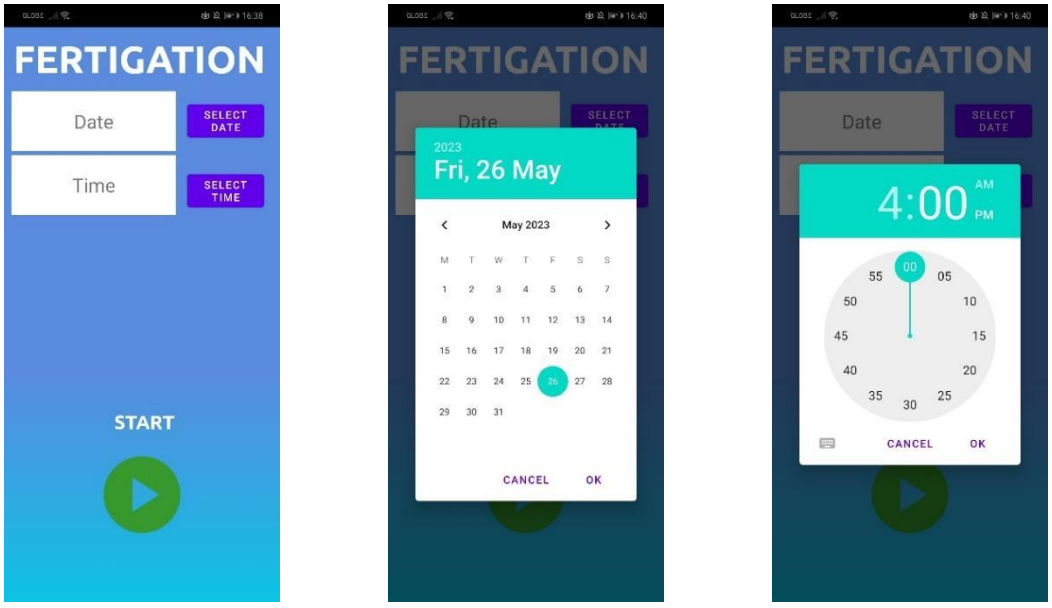


Figure 3.5. Fertigation Scheduling Page

3.4. Monitoring

The monitoring page includes a visual indicator for the values of the different sensors from the system as well as if the WaterWorks - AI system is currently active or inactive.

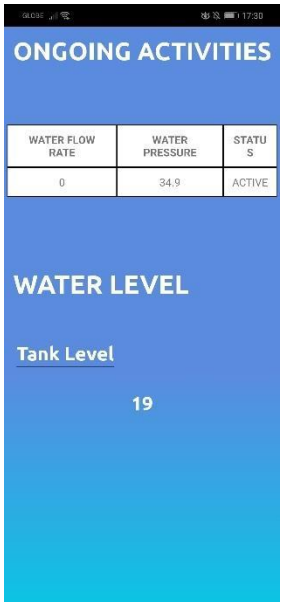


Figure 3.6. Monitoring Page

3.5. Previous Activities

The previous activities feature shows the history page that displays the 10 most recent activities of the system.

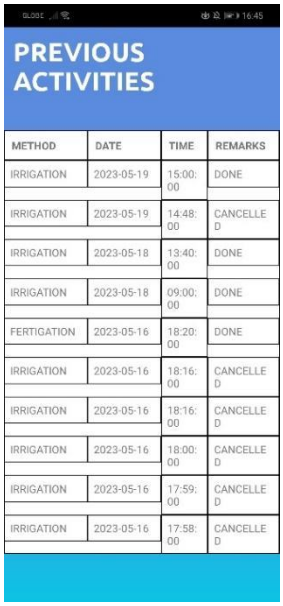


Figure 3.7. History Page

3.6. Upcoming Activities

The upcoming activities feature shows the schedules page that displays the 10 nearest irrigation or fertigation schedule from the database.

Figure 3.8. Schedules Page

3.7. About Us

The about us page displays information on the description of the WaterWorks - AI system.

Figure 3.9. About Us Page

Chapter 4 – Basic Operations

4.1. User Login

- Launch the mobile application on your device.
- On the login page, enter your username and password.
- Tap the "Login" button to access the application.

4.2. Navigating the Application

- After logging in, you will be directed to the dashboard.
- Here you can navigate to access different sections of the application by tapping on them.
- A logout option is included in the dashboard to exit to the login page.

4.3. Setting an Irrigation Schedule

- From the dashboard, select the "Schedule" option to access the scheduling selection page.
- From the scheduling selection page, select the “Irrigation” option to access the irrigation scheduling page.
- From the irrigation scheduling page, specify the irrigation settings by selecting the preferred date and time for an irrigation.
- Save the schedule by tapping the “Start” image button.

4.4. Setting a Fertigation Schedule

- From the dashboard, select the "Schedule" option to access the scheduling selection page.
- From the scheduling selection page, select the “Fertigation” option to access the fertigation scheduling page.
- From the fertigation scheduling page, specify the fertigation settings by selecting the preferred date and time for a fertigation.
- Save the schedule by tapping the “Start” image button.

4.5. Monitoring of the Process

- To monitor the system during an irrigation or fertigation process, navigate back to the “Dashboard” section of the application.
- From the dashboard, select the “Monitoring” option to access the monitoring page that shows the data from the different water-related sensors of the system.

4.6. Checking the Previous Activities

- To check the latest 10 previous activities, navigate back to the “Dashboard” section of the application.
- From the dashboard, select the “Previous Activities” option to access the history page that shows the status of the 10 most recent irrigation or fertigation activities.

4.7. Checking the Upcoming Activities

- To check the upcoming activities, navigate back to the “Dashboard” section of the application.

- From the dashboard, select the “Upcoming Activities” option to access the schedules page that shows the status of the 10 nearest upcoming irrigation or fertigation activities.

Chapter 5 – Offline Operations

5.1. Refilling of Fertilizer

Once the process of fertigation is completed it is advised to check the fertilizer container of the system to see if there is enough fertilizer in the container for a fertigation process in the future. If the amount of fertilizer in the container is not enough then it must be refilled manually by adding liquid fertilizer or a fertilizer and water mixture to the container.

5.2. Water Source

The system can still be operated fully in manual operations in case the system is offline. Filling the water storage for the water source system can be done by utilizing the manual operation of the water motor pump of the system.

Steps:

1. Make sure that the system is powered off by checking the state of the switch.
2. Remove the connection of the power supply to the Wemos D1 R32 ESP32 microcontroller in the circuit by removing the connection of the buck converter connected to it as shown in the circuit diagram in figure 2.7.
3. Turn on the switch to activate the water motor pump manually.
4. Wait for the water storage to be filled.
5. Turn off the switch to stop the operation of the water motor pump.

5.3. Manual Irrigation

The system can distribute water to the drip irrigation system by manual operations using the manual override valve in the distribution system.

Steps:

1. Check and make sure that the water storage container contains an adequate amount of water for an irrigation process.
2. Check and make sure that the gate valve of the distribution system is fully open.

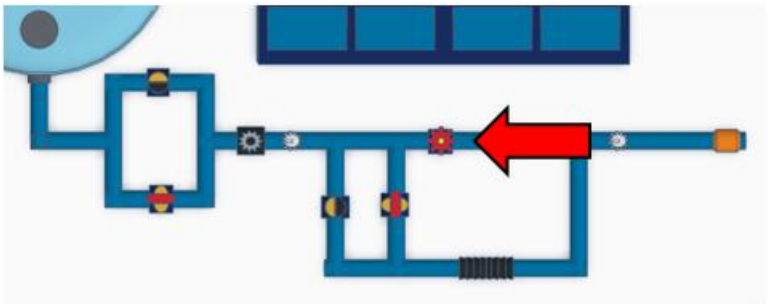


Figure 5.1. Gate Valve of the Distribution System

3. Open the manual override valve for the water source system and the distribution system to let the water flow from the water storage container and into to the drip irrigation system.

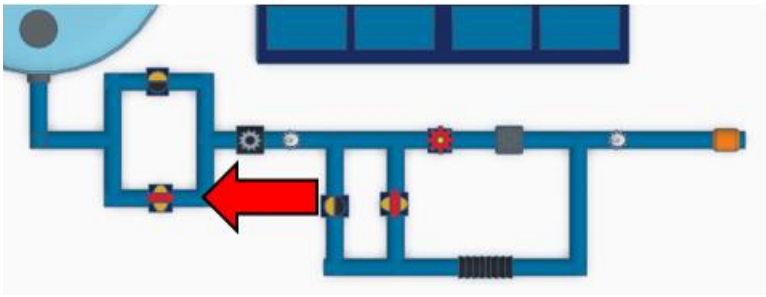


Figure 5.2. Manual Override Valve #1

4. Let the water flow to the drip irrigation system until the crops are fully watered by monitoring the irrigation process or until the user decides to stop the process.
5. To stop the irrigation process, simply turn the manual override valve #1 from open to close.

5.4. Manual Fertigation

The system can also distribute water and fertilizer to the drip irrigation system by manual operations using the manual override valve in the distribution system.

Steps:

1. Check and make sure that the water storage container contains an adequate amount of water for a fertigation process.
2. Check and make sure that the gate valve of the distribution system is fully open.
3. Check and make sure that the fertilizer container contains an adequate amount of liquid fertilizer or fertilizer solution for a fertigation process.
4. Open the manual override valve for the water source system and the distribution system to let the water flow from the water storage container and into to the drip irrigation system.
5. Then open the manual override valve for the bypass assembly in the distribution system.

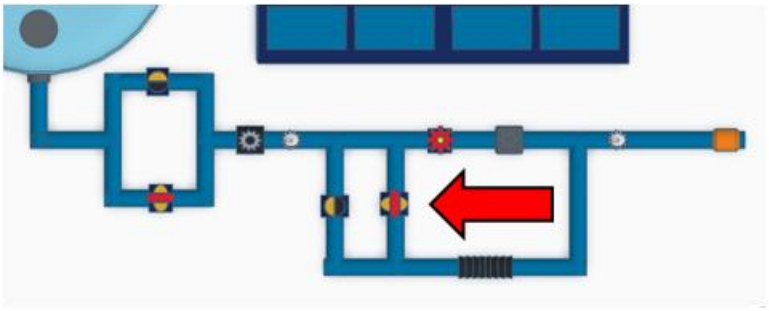


Figure 5.3. Manual Override Valve #2

6. The fertilizer will then be mixed to the flow of water through the venturi fertilizer injector.
7. Let the mixture flow to the drip irrigation system until the crops are fully watered by monitoring the fertigation process or until the user decides to stop the process.
8. To stop the fertigation process, simply turn the manual override valve #1 and manual override valve #2 from open to close.

Chapter 6 – Safety Information

The following safety information is provided as a general guide to promote safe usage and operation of the solar-powered automated fertigation system utilizing a mobile application for irrigation scheduling. It is important to note that while every effort has been made to ensure the accuracy and comprehensiveness of this information, the user assumes all responsibility and risk associated with operating the system.

The manufacturer, provider, or developer of the system shall not be held liable for any damages, injuries, or losses resulting from improper use, negligence, or failure to follow the safety instructions. It is essential to consult local regulations, adhere to manufacturer's instructions, and seek professional guidance when needed to ensure safe and compliant usage.

6.1. General Safety Information

- Conduct regular system checks for maintenance of the system.
- Regularly clean the components of the fertigation system.
- Familiarize yourself with the user manual and safety information
- Contact customer_support@waterworks-ai.online for any questions, concerns, or troubleshooting needs.

6.2. Water and Chemical Handling Safety Information

- Use clean and uncontaminated water sources for fertigation to prevent harm to plants, humans, animals, and the environment.
- Avoid using water sources that may contain harmful chemicals, pollutants, or pathogens.
- Regularly test and monitor the water quality to ensure it meets established standards or guidelines.

- Handle the fertilizers or other chemicals with caution and wearing the appropriate protective gear.
- Store chemicals in a secure location, out of reach of children and pets.
- Dispose of chemical containers and waste properly, following local regulations and guidelines.

6.3. Mobile Application Safety Information

- Keep the mobile application updated to the latest version to ensure optimal functionality and security.
- Create strong and unique passwords to protect access to the application.
- Avoid sharing sensitive or personal information through the application unless necessary.

ANNEX V
MANUAL TO DUPLICATE THE SYSTEM

Chapter 1 – Introduction

1.1. Overview

The WaterWorks AI is a solar-powered automated fertigation system with irrigation scheduling and water flow control system for field crops using a microcontroller, solenoid valves, and water-related sensors. It utilizes drip irrigation for the precision and efficiency of delivering water and fertilizers directly to the roots of plants.

The system is designed to reduce water consumption and prevent over-irrigation by smartly monitoring the water flow rate of the system and applying an optimal quantity of fertilizer for field crops by adjusting the flow rate and water pressure of the system. It also utilizes an android mobile application as a controller for the system.

This manual serves as a comprehensive guide on duplicating the prototype.

Chapter 2 – List of Materials and Equipment

Materials	Quantity
100W Solar Panel	2
0.5kg Pack of Nails	1
10x10" PCB	
12V 150Ah Battery	1
12V to 5V Buck Converter	2
14 AWG Cables 1m	1
16 AWG Cables 1m	5
2-Channel 5V Relay Module	1
3x30 Screw with nuts [SCW-10PR-3X30] (10 pcs.)	1
4-Channel 5V Relay Module	1
Ball Valve 1"	2
Brass Gate Valve 1"	1
Brass Globe Valve 1"	1
DFRobot Analog Water Pressure Sensor	2
Drip Irrigation Kit	1
DS3231 RTC Module	1
Electrical Tape	1
Ferric Chloride Bottle 16oz	3
Foot Valve	1
FS400A-G1 Water Flow Sensor	1
HDPE Drum	1
Heat Sink	1
JSN-SR04T Ultrasonic Sensor	1
LSWQB 12V Water Motor Pump	1

Male-Female Jumper Cables 30cm (40 pcs.)	1
Male-Male Jumper Cables 1m (10 pcs.)	3
Male-Male Jumper Cables 30cm (40 pcs.)	1
Neltex Cement 200cc	2
Nema 23 19kg-cm Stepper Motor	1
Nylon Spacer [HTP-M325-10P] (10 pcs.)	1
Plastic Pail	1
PVC Elbow Connector 1"	8
PVC Elbow Connector 3/4"	4
PVC Female Adaptor 1" Threaded	1
PVC Male Adaptor 1" Threaded	3
PVC Pipes 1"	3
PVC Pipes 3/4"	2
PVC Reducer 1” to 3/4"	3
PVC Tee Connector 1"	5
PVC Tee Connector 1" Threaded	2
Solar Panel Mount	1
Solenoid Valve 1" 12V DC	2
Switch	1
TB6600 Stepper Motor Driver	1
Teflon Tape	3
Venturi Fertilizer Injector 3/4"	1
Wemos D1 R32 ESP32 Microcontroller	1

Chapter 3 – Safety Considerations

Safety is paramount during the duplication process. Adhere to the following safety guidelines:

1. Electrical Safety:

    - Prioritize electrical safety when working with power supplies and connections.
    - Ensure all electrical components, including power supplies and wiring, meet safety standards and are in good condition.
    - Handle electronic components with care to prevent damage or contamination.
    - Follow proper grounding procedures to prevent electrical hazards.
    - Disconnect power sources before making any modifications or adjustments to the system.
    - Avoid water contact with electrical components to prevent electric shocks or short circuits.

2. Piping and Fittings:

    - Select piping and fittings made of materials suitable for use with water and fertilizers.
    - Ensure all piping and fittings are compatible, properly sized, and securely connected to prevent leaks.
    - Check for any defects, cracks, or signs of deterioration in the piping and fittings.

- Use appropriate tools and techniques for cutting, bending, and joining piping to prevent injuries.

3. Documentation and User Manuals:

- Maintain and follow the manufacturer's documentation and user manuals for all materials and equipment used in the fertigation system.
- Familiarize yourself and all personnel involved with the operation, maintenance, and safety guidelines specific to each component.

Chapter 4 – Installation Setup

4.1. Hardware

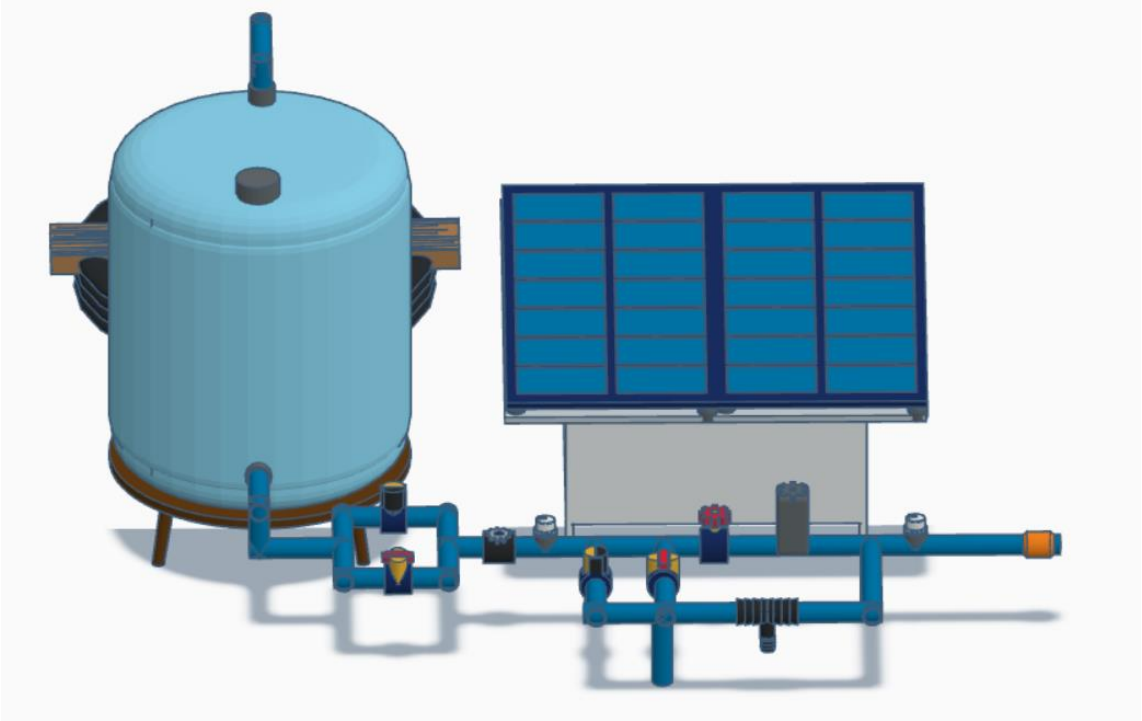


Figure 4.1. Full System Setup Design

The hardware components of the WaterWorks AI comprise of a water source system, a control system, and a distribution system. The water source system consists of a water motor pump that is connected to a water source, a water storage container for storing water, PVC pipes, and an ultrasonic sensor for automatically detecting the water level inside the water storage container.

The water motor pump in the water source system will be connected to a deep well system by using a 1" male adaptor, 1" elbow connector and a 1" PVC pipe with a length that is adequate for reaching the water in the deep well in the inlet of the motor. The outlet of the motor will then be connected to a 1" male adaptor, 1" elbow connector and a 1" to 3/4" reducer connecting a 3/4" PVC pipe to

the top of the HDPE drum using multiple 3/4" elbow connectors along with an ultrasonic sensor for water level sensing.

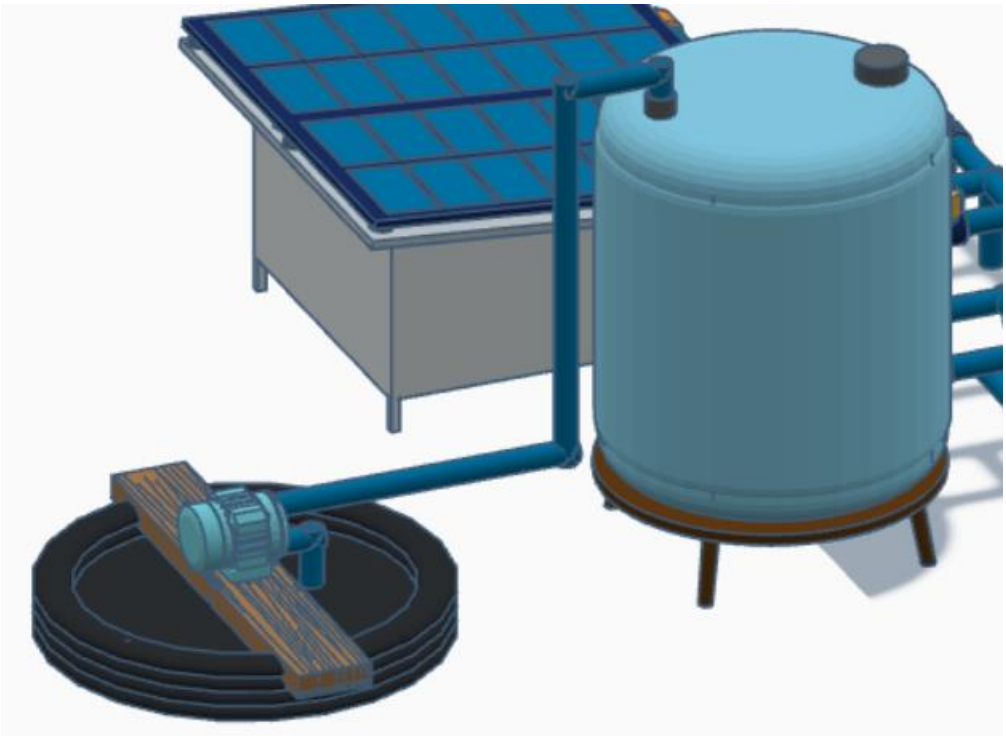


Figure 4.2. Water Source System Setup Design

The control system will utilize a custom-made solar panel mount that also acts as a housing for the different electronic components for the system. The solar panels are attached to the top of the housing which acts as a roof to the components.

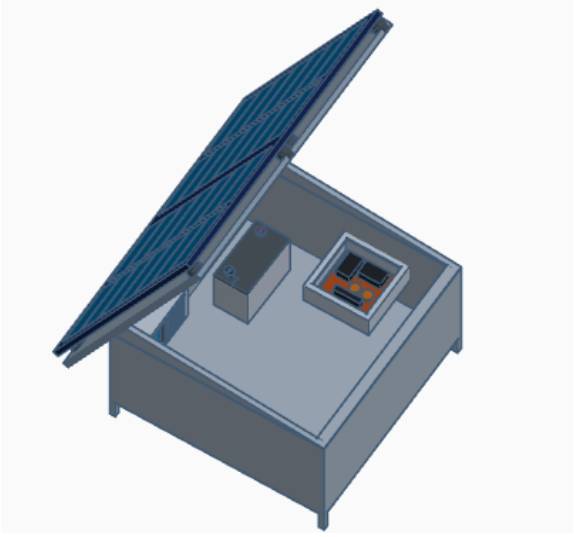


Figure 4.3. Housing Design of the Control System

The design for the distribution system utilizes the outlet of the water source system wherein the HDPE tank is connected to 1" elbow connectors to the position of the distribution system. The inlet of the distribution system uses a tee connector that creates a parallel connection to the piping of the system for the automated and manual override function. The automated function utilizes a 1" solenoid valve while the manual override utilizes a 1" ball valve. Both connections will then be combined using another 1" tee connector connecting it to water flow sensor and into the main water pipeline of the bypass assembly.

The main water pipeline includes a normally-open gate valve and a normally-open stepper-controlled globe valve for allowing water or mixture to pass through the system and onto the outlet of the distribution system which will then be connected to a drip irrigation system depending on the specifications of the position of the plants. A bypass water pipeline is also included in the assembly wherein another 1" solenoid valve and 1" ball valve are connected using a 1" tee connector. The valves are then connected to a 1" to 3/4" reducer and to the venturi fertilizer injector. The injector will then be connected to the plastic pail that will be used for storing fertilizers and it will also be connected to the outlet of the distribution system through a 1" to 3/4" reducer and a 1" tee connector.

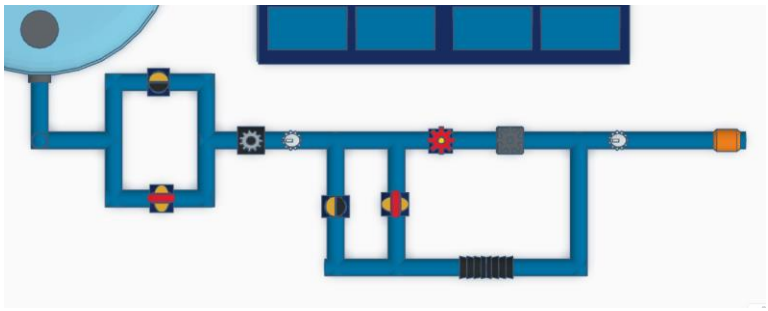


Figure 4.4. Design of the Distribution System

4.2. Circuit Diagram

The circuit diagram for the automated fertigation system incorporates several essential components. The system starts with solar panels that harness sunlight to generate electrical power, which is then stored in a battery. Sensors such as an ultrasonic sensor, water flow sensor, and water pressure sensors are integrated into the circuit to monitor the water level and water flow rates. These sensors provide valuable data to the system. The system utilizes solenoid valves and a stepper-controlled globe valve for controlling the flow of water during an irrigation or fertigation process. The entire system is designed to operate autonomously utilizing a microcontroller, with the solar panels charging the battery and providing power to the sensors and solenoid valves. This circuit diagram for the system is shown in the figure below:

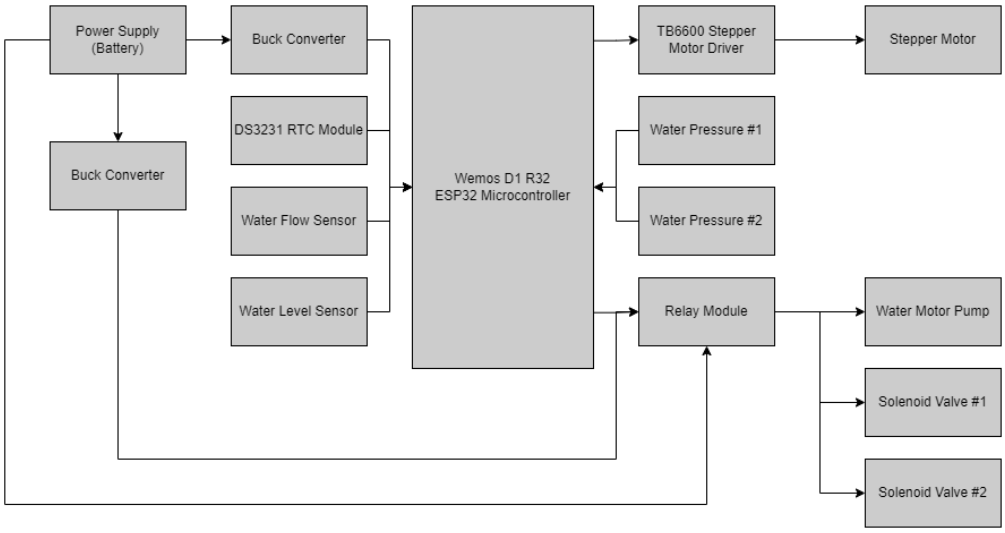
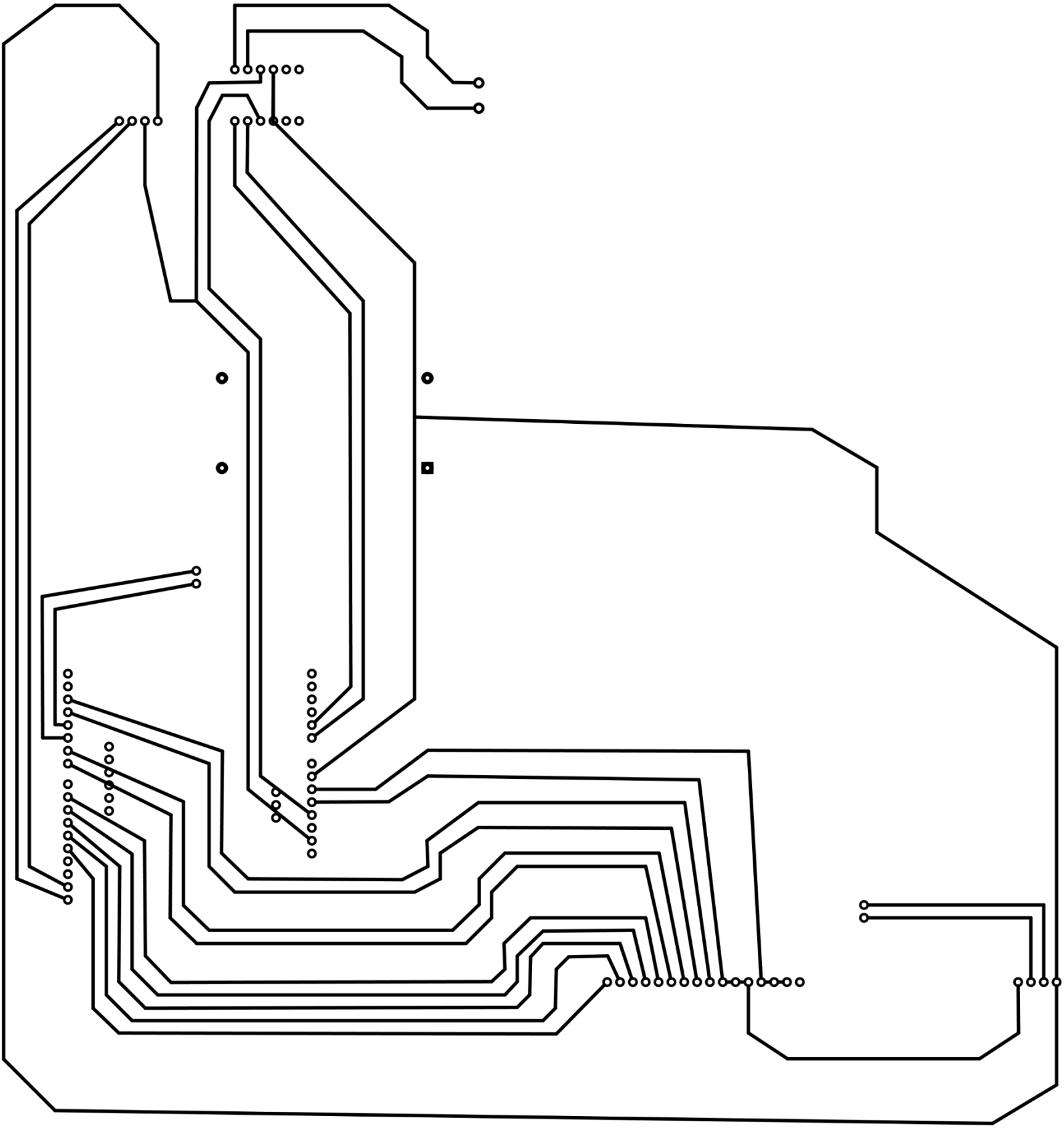


Figure 4.5. Circuit Diagram

The design for the layout of the PCB etch is provided in the next page.



5.1. Web Hosting

A web hosting site is utilized for creating a database system and for storing the PHP files for the different process or instructions for the database. This web application, however, will not be shown to the users and is also developed for the back-end processing of data from the system and to the mobile application through the database system.

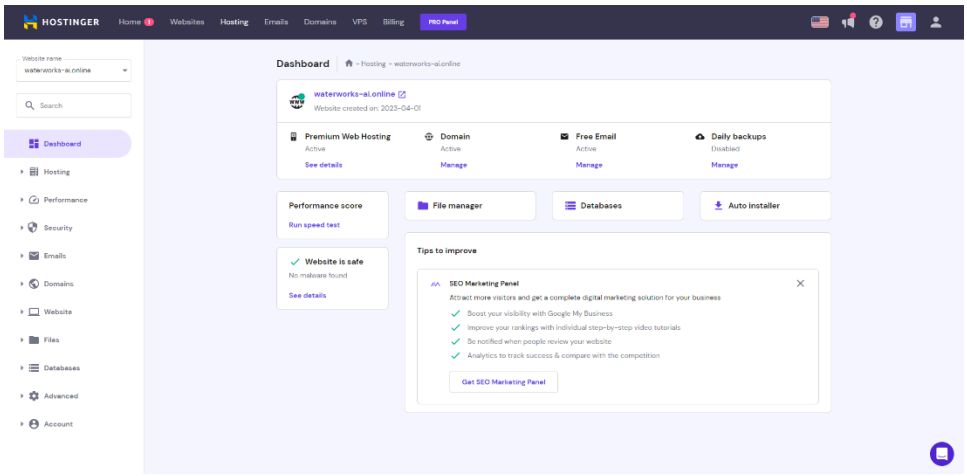


Figure 5.1. Dashboard of the Web Hosting Site

5.2. Database System

A database system will be developed using a web hosting service that will store information about the irrigation schedules set by the user of the system. The development of the database will use the programming languages PHP and SQL.

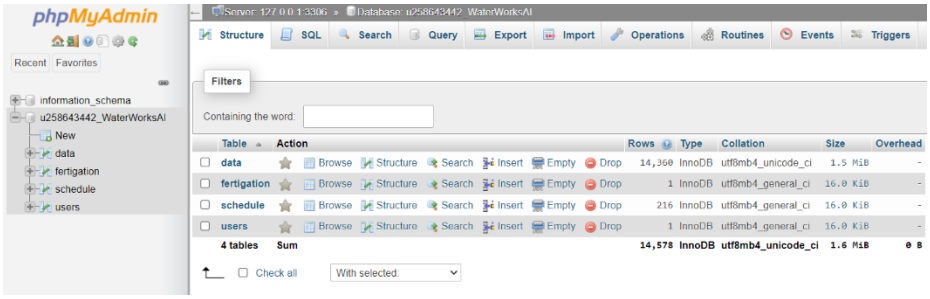


Figure 5.2. Database System using phpMyAdmin

The database will be able to send and receive data from the system and the mobile application through the use of multiple PHP files for different processes that is essential to the overall system which includes:

- Login
- Registering a new user account
- Receiving sensor data

- Receiving schedule data
- Sending sensor data
- Sending schedule data

These processes follow a specific format in programming using PHP which is:

Figure 5.3. Login PHP file

5.3. System Development using Arduino

The embedded system for the automated fertigation system uses the Arduino modified C++ programming language which is compatible with the Wemos D1 R32 ESP32 microcontroller.

The flow of the system is as shown:

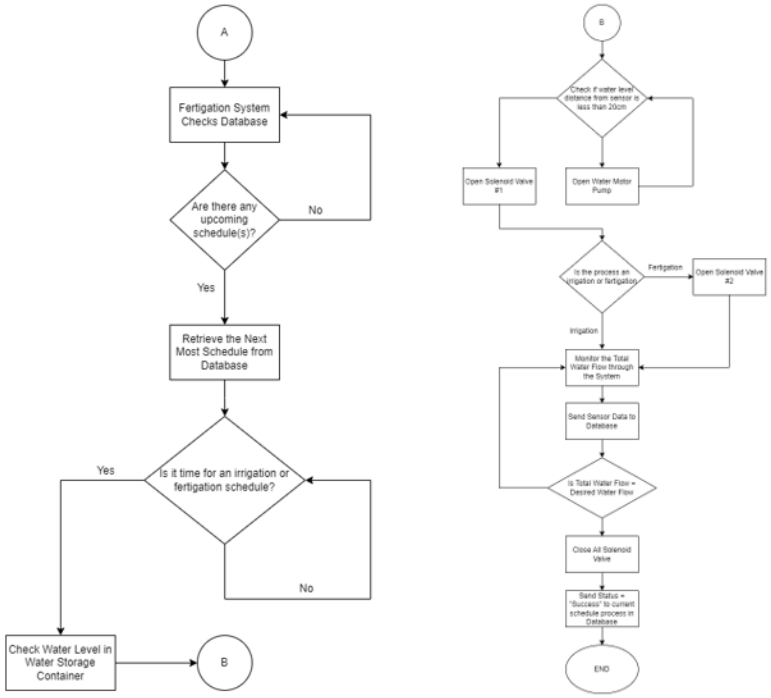
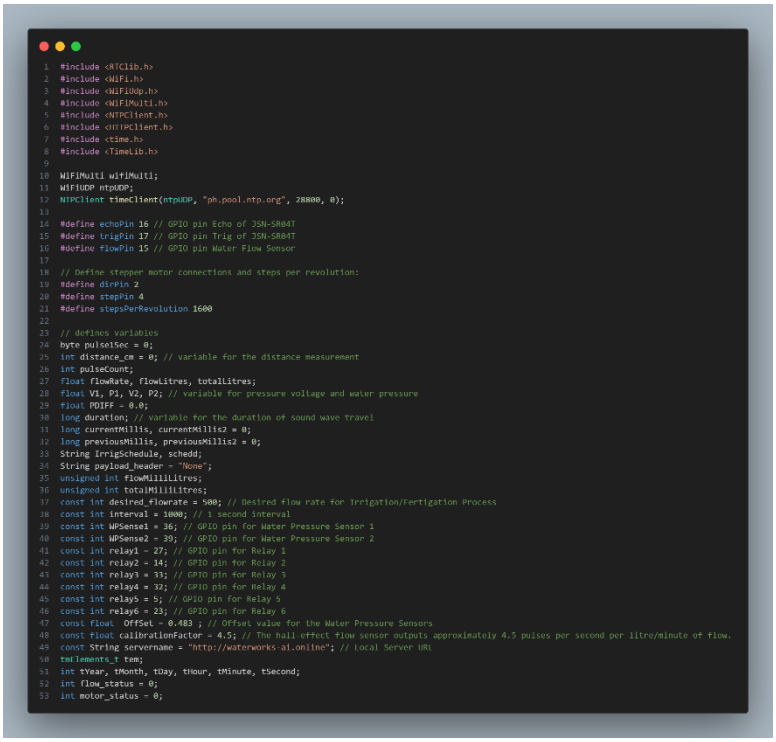


Figure 5.4. Automated Fertigation System Flowchart

The figure below shows the list of libraries and variables needed by the system to operate.



```
#include <RTClib.h>
#include <WiFi.h>
#include <WiFiUdp.h>
#include <WiFiMulti.h>
#include <NTPClient.h>
#include <HTTPClient.h>
#include <time.h>
#include <TimeLib.h>

WiFiMulti wifiMulti;
WiFiUDP ntpUDP;
NTPClient timeClient(ntpUDP, "ph.pool.ntp.org", 28800, 0);

#define echoPin 16 // GPIO pin Echo of JSN-SR04T
#define trigPin 17 // GPIO pin Trig of JSN-SR04T
#define flowPin 15 // GPIO pin Water Flow Sensor

// Define stepper motor connections and steps per revolution:
#define dirPin 2
#define stepPin 4
#define stepsPerRevolution 1600

// defines variables
byte pulse1Sec = 0;
int distance_cm = 0; // variable for the distance measurement
int pulseCount;
float flowRate, flowLitres, totalLitres;
float V1, P1, V2, P2; // variable for pressure voltage and water pressure
float PDIFF = 0.0;
long duration; // variable for the duration of sound wave travel
long currentMillis, currentMillis2 = 0;
long previousMillis, previousMillis2 = 0;
String IrrigSchedule, schedd;
String payload_header = "None";
unsigned int flowMilliLitres;
unsigned int totalMilliLitres;
const int desired_flowrate = 500; // Desired flow rate for Irrigation/Fertigation Process
const int interval = 1000; // 1 second interval
const int WPSense1 = 36; // GPIO pin for Water Pressure Sensor 1
const int WPSense2 = 39; // GPIO pin for Water Pressure Sensor 2
const int relay1 = 27; // GPIO pin for Relay 1
const int relay2 = 14; // GPIO pin for Relay 2
const int relay3 = 33; // GPIO pin for Relay 3
const int relay4 = 32; // GPIO pin for Relay 4
const int relay5 = 5; // GPIO pin for Relay 5
const int relay6 = 23; // GPIO pin for Relay 6
const float  OffSet = 0.483 ; // Offset value for the Water Pressure Sensors
const float calibrationFactor = 4.5; // The hall effect flow sensor outputs approximately 4.5 pulses per second per litre/minute of flow.
const String servername = "http://waterworks-a1.online"; // Local Server URL
tmElements_t tm;
int tYear, tMonth, tDay, tHour, tMinute, tSecond;
int flow_status = 0;
int motor_status = 0;
```

Figure 5.5. List of Dependencies

An initial setup for the system includes the setup for the different sensors and relays connected to the circuit, the setup for the connecting to a WiFi connection, the setup and calibration of the Real-Time Clock module, initial conditions of the relay modules, and a falling interrupt condition for the water flow sensor.

```
void setup() {
  // put your setup code here, to run once:
    Serial.begin(115200);
    delay(100);

    wifiMulti.addAP("SSID","PASSWORD");

    while (wifiMulti.run() != WL_CONNECTED) {
    delay(500);
    Serial.print(".");
    }

    timeClient.begin();
    delay(100);

    pinMode(relay1, OUTPUT);
    pinMode(relay2, OUTPUT);
    pinMode(relay3, OUTPUT);
    pinMode(relay4, OUTPUT);
    pinMode(relay5, OUTPUT);
    pinMode(relay6, OUTPUT);
    pinMode(trigPin, OUTPUT); // Sets the trigPin as an OUTPUT
    pinMode(echoPin, INPUT); // Sets the echoPin as an INPUT
    pinMode(flowPin, INPUT);
    pinMode(WPSense1, INPUT);
    pinMode(WPSense2, INPUT);

    digitalWrite(flowPin, HIGH);

    digitalWrite(relay1, LOW);
    delay(100);
    digitalWrite(relay2, LOW);
    delay(100);
    digitalWrite(relay3, HIGH);
    delay(100);
    digitalWrite(relay4, HIGH);
    delay(100);
    digitalWrite(relay5, HIGH);
    delay(100);
    digitalWrite(relay6, HIGH);
    delay(100);

    rtc.begin()
    delay(2000);

    if (rtc.lostPower()) {
    Serial.println("RTC lost power, lets set the time!");
    rtc_calibrate();
    }

    pulseCount        = 0;
    flowRate          = 0.0;
    flowMilliLitres   = 0;
    totalMilliLitres  = 0;
    previousMillis    = 0;
    previousMillis2    = 0;

    // Configured to trigger on a FALLING state change (transition from HIGH state to LOW state)
    attachInterrupt(digitalPinToInterrupt(flowPin), pulseCounter, FALLING);

}
```

Figure 5.6. Code for the Setup of the Control Circuit

The main loop of the system includes a code for testing and configuration of the different sensors and component in the circuit but the primary function of the loop is to get an irrigation or fertigation schedule from the database and check the current time as shown in the figure below.

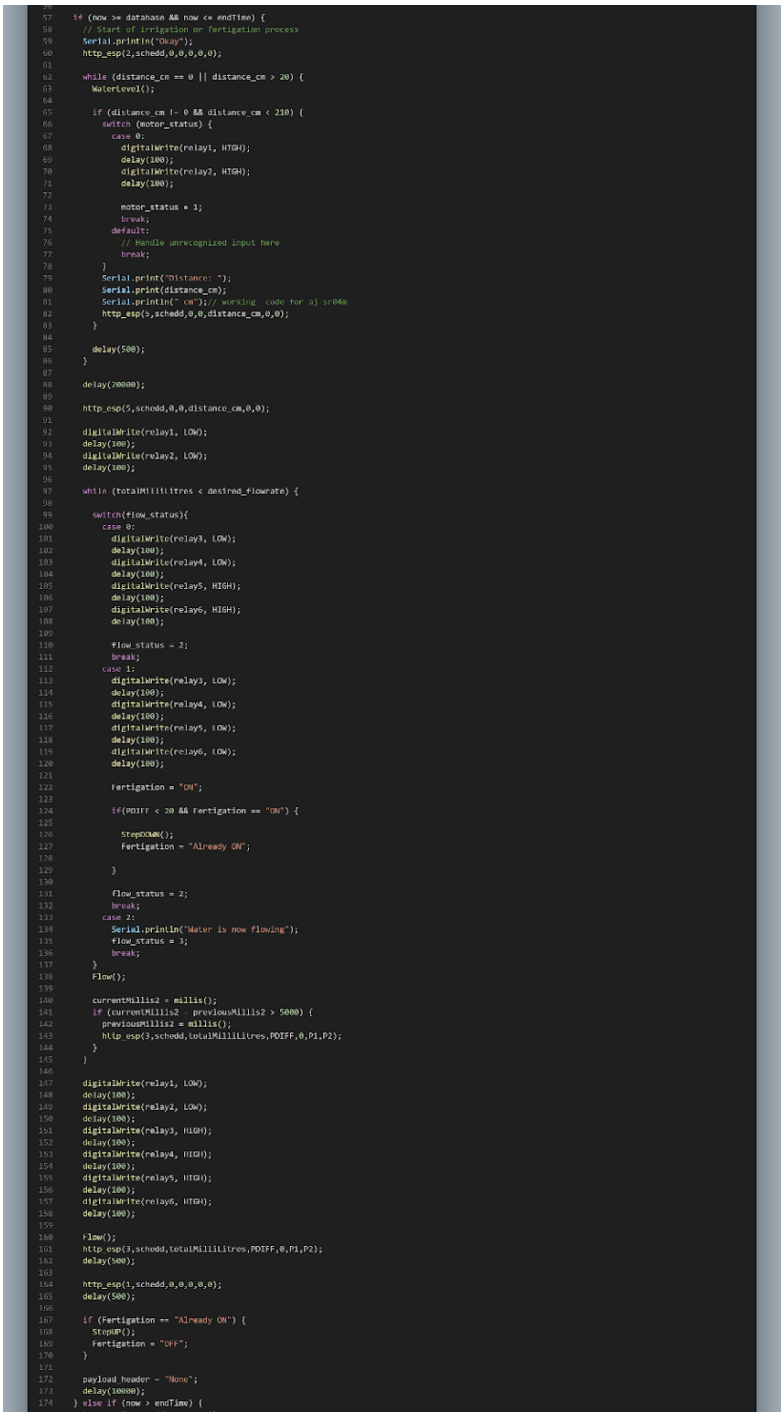
```
void loop() {
  // put your main code here, to run repeatedly:

  if (payload_header == "None") {
    totalMilliLitres = 0;
    http_esp(0,"",0,0,0,0,0);
    Serial.println(IrrigSchedule);
  } else {
    checkschedule(IrrigSchedule);
  }
  delay(1000);

}
```

Figure 5.7. Code for the Main Loop of the Control Circuit

The main logic of the system for an irrigation or fertigation process is included in the checkschedule() function wherein once the current time of the system matches the date retrieved from the database then an irrigation or fertigation process will occur. The other functions in the code are for the sending or retrieving of the data to the database and the functions for collecting data from the different sensors of the circuit.



```
  if (now >= database && now <= endTime) {
    // Start of irrigation or fertigation process
    Serial.println("Okay");
    http_esp(2,schedd,0,0,0,0,0);

    while (distance_cm == 0 || distance_cm > 20) {
      WaterLevel();

      if (distance_cm != 0 && distance_cm < 210) {
        switch (motor_status) {
          case 0:
            digitalWrite(relay1, HIGH);
            delay(100);
            digitalWrite(relay2, HIGH);
            delay(100);

            motor_status = 1;
            break;
          default:
            // Handle unrecognized input here
            break;
        }
        Serial.print("Distance: ");
        Serial.print(distance_cm);
        Serial.println(" cm");// working  code for aj sr04m
        http_esp(5,schedd,0,0,distance_cm,0,0);
      }

      delay(500);
    }

    delay(20000);

    http_esp(5,schedd,0,0,distance_cm,0,0);

    digitalWrite(relay1, LOW);
    delay(100);
    digitalWrite(relay2, LOW);
    delay(100);

    while (totalMillilitres < desired_flowrate) {

      switch(flow_status){
        case 0:
          digitalWrite(relay3, LOW);
          delay(100);
          digitalWrite(relay4, LOW);
          delay(100);
          digitalWrite(relay5, HIGH);
          delay(100);
          digitalWrite(relay6, HIGH);
          delay(100);

          flow_status = 2;
          break;
        case 1:
          digitalWrite(relay3, LOW);
          delay(100);
          digitalWrite(relay4, LOW);
          delay(100);
          digitalWrite(relay5, LOW);
          delay(100);
          digitalWrite(relay6, LOW);
          delay(100);

          fertigation = "ON";

          if(PDIFF < 20 && fertigation == "ON") {

            StepDOWN();
            fertigation = "Already ON";

          }

          flow_status = 2;
          break;
        case 2:
          Serial.println("Water is now flowing");
          flow_status = 3;
          break;
      }
      Flow();

      currentMillis2 = millis();
      if (currentMillis2 - previousMillis2 > 5000) {
        previousMillis2 = millis();
        http_esp(3,schedd,totalMilliLitres,PDIFF,0,P1,P2);
      }
    }

    digitalWrite(relay1, LOW);
    delay(100);
    digitalWrite(relay2, LOW);
    delay(100);
    digitalWrite(relay3, HIGH);
    delay(100);
    digitalWrite(relay4, HIGH);
    delay(100);
    digitalWrite(relay5, HIGH);
    delay(100);
    digitalWrite(relay6, HIGH);
    delay(100);

    Flow();
    http_esp(3,schedd,totalMilliLitres,PDIFF,0,P1,P2);
    delay(500);

    http_esp(1,schedd,0,0,0,0,0);
    delay(500);

    if (fertigation == "Already ON") {
      StepUP();
      fertigation = "OFF";
    }

    payload_header = "None";
    delay(10000);
  } else if (now > endTime) {
```

Figure 5.8. Main Logic for the Irrigation or Fertigation Process

5.4. Mobile Application Development

A partner mobile application is also utilized for the automated fertigation system. This serves as a controller for the irrigation scheduling feature of the system as well as a monitoring device for the different sensor data of the system. The primary functions of the application include:

- Login page
- Dashboard
- Scheduler
- Monitoring page
- Showing the list of previous and upcoming activities
- Showing information about the system

Figure 5.9. Automated Fertigation System Flowchart

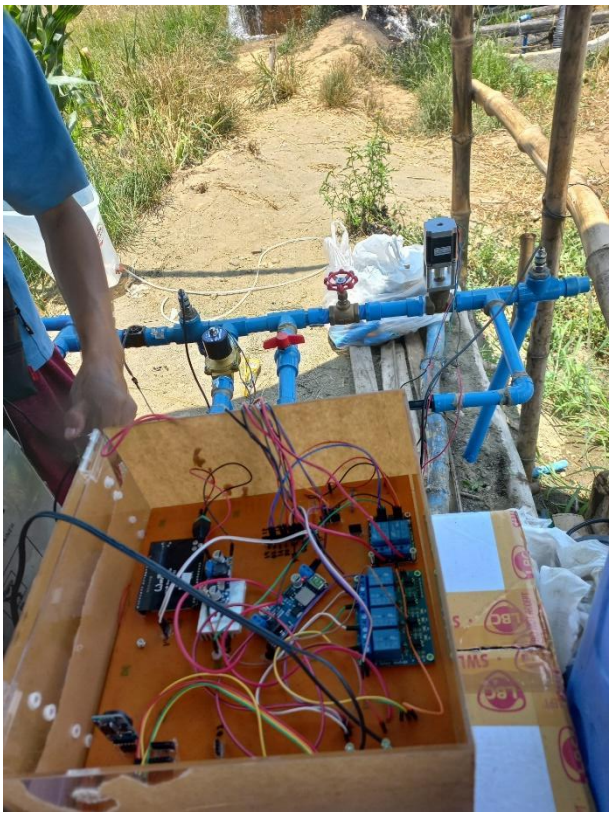
ANNEX VI
DOCUMENTATION


ROCKET
CAUTION

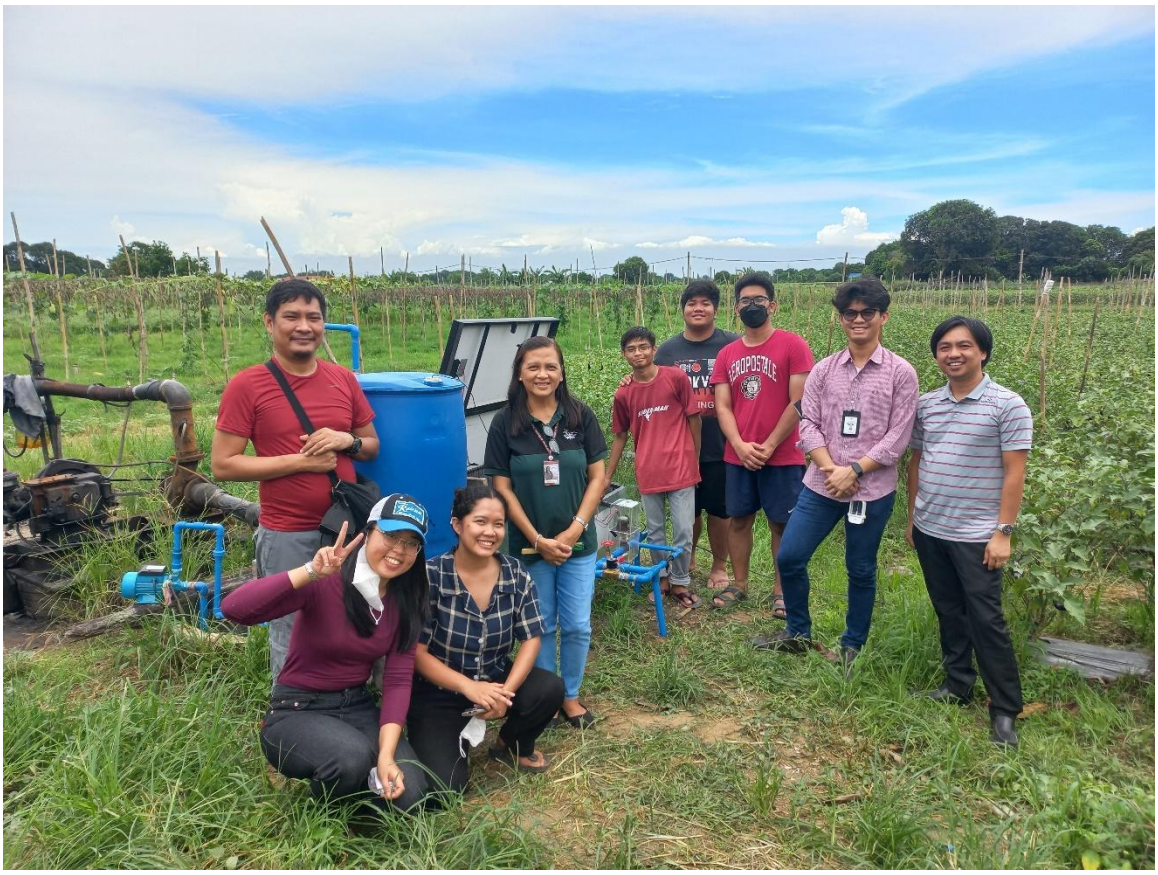

Dickies


BALL
IS
LIFE


FERDINAND DENNIS E BARTOLOME-REA
MUNICIPAL ASSESSOR



SITE VISIT WITH ECE FACULTIES



ANNEX VII
DEFENSE PHOTOS

TOPIC DEFENSE

TITLE DEFENSE

PROGRESS DEFENSE

PRE-FINAL DEFENSE

APPRECIATE


ANOVA
CERNOW

FINAL DEFENSE


ECE UNDERGRADUATE THESIS
FINAL DEFENSE

ANNEX VIII
STUDENT'S PROFILE

PAUL BRYAN C. UMALI

paulbryanc.umali@gmail.com
+639456079942
Molino IV, City of Bacoor, Cavite

Personal Information

Date of Birth:	October 11, 1999
Place of Birth:	City of Bacoor, Cavite
Nationality:	Filipino
Sex:	Male

Technical Skills

Proficient:	Filmora, Photoshop, Canva, Microsoft Office, Cisco Packet Tracer, Arduino IDE
Intermediate:	NI Multisim, TinkerCAD, Octave, MATLAB
Beginner:	RStudio, Python, Android Studio, LT Spice, HTML, CSS, JavaScript

Other Skills

- Project Management
- Leadership
- Time Management
- Digital/Graphic Design
- Data Visualization
- Communication
- Team Player
- Solo Player
- Problem-solving
- Adaptability
- Creative

About Me

"An individual with a goal of finding and creating good opportunities in further growing myself and expanding my knowledge in every task I will handle that will utilize the skills I have learned."

Education Background

- **TECHNOLOGICAL UNIVERSITY OF THE PHILIPPINES - MANILA | College**
  Bachelor of Science in Electronics Engineering
  2018- Present
  Ayala Blvd., corner San Marcelino St., Ermita, Manila 1000

- **University of Perpetual Help System Dalta - Molino | Senior High School**
  Science, Technology, Engineering, Math (STEM)
  2016 - 2018 | With Honors
  Molino III, City of Bacoor, Cavite | 4102

- **Bacoor National High School - Villa Maria Annex | Junior High School**
  2012 -2016
  Molino III, City of Bacoor, Cavite | 4102

- **Likha Molino Elementary School | Elementary School**
  2008 - 2012 | Honor Student, Model Pupil
  Molino IV, City of Bacoor, Cavite | 4102

- **Bayanan Elementary School | Elementary School**
  2006 - 2008
  Molino I, City of Bacoor, Cavite | 4102

Affiliations / Certifications

April 17, 2023 **FORTINET NSE CERTIFICATION PROGRAM**
NSE 1 NETWORK ASSOCIATE

April 22, 2023 **FORTINET NSE CERTIFICATION PROGRAM**
NSE 2 NETWORK ASSOCIATE

May 01, 2023 **FORTINET NSE CERTIFICATION PROGRAM**
NSE 3 NETWORK ASSOCIATE

Seminars Attended

- **Open RAN Deployment Challenges and Testing Needs**
  April 29, 2023
  Asia Open RAN Academy
- **Introduction to Artificial Intelligence & Machine Learning**
  May 06, 2023
  Asia Open RAN Academy
- **Dynamic Spectrum Sharing and Open RAN**
  May 13, 2023
- **Dynamic Spectrum Sharing and Open RAN**
  May 27, 2023
  Asia Open RAN Academy
- **Patent Search Seminar**
  June 10, 2023
- **iLEAP Plus: IP 101 - Discovering your IP Rights**
  June 06, 2023
- **NEXT GENERATION QUALIFICATION: The Role of Physics of Failure and Artificial Intelligence in Electronics**
  April 4, 2023
  Dr. Michael Pecht
- **UNLEASHING THE POWER OF DATA: SAP Analytics Cloud Workshop**
  April 13, 2023
  Engr. Roy Joseph R. Roberto
- **STEP UP: Paradigmatic Career in Today's Semiconductor Industry**
  April 24, 2023
  Engr. Aaron U. Aquino
- **APP DEV INSIDER: Behind the Scens of Application Development Using Flutter**
  May 4, 2023
  Mr. John Lester Necesito
- **CONNECTING THE UNCONNECTED: Exploring the Potential of LORAWAN in Revolutionizing IOT Connectivity for a Smarter World**
  May 29, 2023
  Mr. Rommel Jay Gadil
- **UNLOCKING THE LIMITLESS: Getting Cloud-Powered with Google Cloud Platform**
  June 2, 2023
  Mr. Juan Miguel Mendoza
- **HACK-PROOF YOUR DIGITAL LIFE: A Beginner's Guide to Information Security**
  June 5, 2023
  Engr. Keshav Das Manalo
- **BUILDING BLOCKS OF IC Design: A Primer for Graduating Electronics Engineering Students**
  June 20, 2023
  Engr. Glenn C. Virrey

Character Reference

Engr. Glenn C. Virrey, ECT Faculty, ECE
Department, Techonological University of the Philippines - Manila 09178707167
glenncalvin_virrey@tup.edu.ph

EMs. Eurika Innah Alyza M. Estocapio
Contact No.: 09065739475

I hereby declare that all the information given above is true and correct to the best of my knowledge. All the information shared in the resume is correct, and I take full responsibility for its correctness. aragraph text

Umali, Paul Bryan c.
Applicant

JIREH DAWN A. CRUZ

cruz.jirehdawn@gmail.com
+639163207552/+639303014212
918 M. Naval St., Brgy. San Jose, Navotas City 1485

Personal Information

Date of Birth:	October 7, 2000
Place of Birth:	Manila
Nationality:	Filipino
Sex:	Female

Technical Skills

Proficient:	MS Office Suite, Canva
Intermediate:	NI Multisim, Design Spark, TinkerCAD, Octave, DesignSpark
Beginner:	RStudio, Cisco Packet Tracer, MATLAB, Python, Android Studio, LT Spice, Arduino

Other Skills

- Highly determined and dedicated towards work
- Open to new ideas and concepts
- Open to feedbacks
- Detail-oriented
- Well-organized
- Can work independently or as part of a team
- Able to work individually without direct supervision
- Good at multitasking
- Can deal with stressful situations in a calm and professional manner
- Professional attitude and motivational approach to work
- Readiness to learn and eagerness to grow

About Me

A BS in Electronics Engineering graduate from Technological University of the Philippines-Manila, who is a hardworking and composed individual, seeking for good training of professional practice to experience in this field.

Education Background

- **TECHNOLOGICAL UNIVERSITY OF THE PHILIPPINES - MANILA | College**
  Bachelor of Science in Electronics Engineering
  2018- Present
  Ayala Blvd., corner San Marcelino St., Ermita, Manila 1000

- **UNIVERSITY OF THE EAST CALOOCAN | Senior High School**
  Science, Technology, Engineering, Math (STEM)
  2016 - 2018 | With Honors
  Samson Road, Caloocan City, Manila 1400

- **NAVOTAS NATIONAL HIGH SCHOOL | Junior High School**
  2012 - 2016 | With Honors
  M. Naval St., Brgy. Sipac ALmacen, Navotas City, Manila

- **BAGUMBAYAN ELEMENTARY SCHOOL | Pre Elementary to Elementary**
  2003 - 2012 | Salutatorian
  M. Naval St., Brgy. Sipac ALmacen, Navotas City, Manila

Affiliations / Certifications

June 2023	**CIVIL SERVICE EXAM: PROFESSIONAL LEVEL PASSER**
2018 - Present	**CHED TULONG DUNONG PROGRAM** Scholar
2018 - Present	**INSTITUTE OF ELECTRONICS ENGINEERS OF THE PHILIPPINES, INC.** Member

August 2022 **DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS-MNDEO**
Internship / On-the-Job Training

May 2023 **FORTINET NSE CERTIFICATION PROGRAM**
NSE 1 NETWORK ASSOCIATE

May 2023 **FORTINET NSE CERTIFICATION PROGRAM**
NSE 2 NETWORK ASSOCIATE

June 2023 **FORTINET NSE CERTIFICATION PROGRAM**
NSE 3 NETWORK ASSOCIATE

Seminars Attended

- **THE AGILE ETHOS: Turning Small Increments into Huge Developments**
  June 18, 2022
  Engr. Emman Navalan
- **NAVIGATING SYNTAX SENTIMENTS IN THE TRANSFORMING WORLD: Neural Networks and Natural Language Processing**
  June 18, 2022
  Dr. Charibeth Cheng
- **FIRE DETECTION AND ALARM SYSTEMS**
  April 24, 2022
- **NEXT LEVEL: Artificial Intelligence Trends in the 21st Century**
  March 12, 2022
  Dr. Ira C. C. Valenzuela-Estropia
- **GLOBAL YOUTH SUMMIT 2018**
  August 2018
- **TechEX: Biomedical Technology 101**
  December 21, 2021
- **NEXT GENERATION QUALIFICATION: The Role of Physics of Failure and Artificial Intelligence in Electronics**
  April 4, 2023
  Dr. Michael Pecht
- **UNLEASHING THE POWER OF DATA: SAP Analytics Cloud Workshop**
  April 13, 2023
  Engr. Roy Joseph R. Roberto
- **STEP UP: Paradigmatic Career in Today's Semiconductor Industry**
  April 24, 2023
  Engr. Aaron U. Aquino
- **APP DEV INSIDER: Behind the Scens of Application Development Using Flutter**
  May 4, 2023
  Mr. John Lester Necesito
- **CONNECTING THE UNCONNECTED: Exploring the Potential of LORAWAN in Revolutionizing IOT Connectivity for a Smarter World**
  May 29, 2023
  Mr. Rommel Jay Gadil
- **UNLOCKING THE LIMITLESS: Getting Cloud-Powered with Google Cloud Platform**
  June 2, 2023
  Mr. Juan Miguel Mendoza
- **HACK-PROOF YOUR DIGITAL LIFE: A Beginner's Guide to Information Security**
  June 5, 2023
  Engr. Keshav Das Manalo
- **BUILDING BLOCKS OF IC Design: A Primer for Graduating Electronics Engineering Students**
  June 20, 2023
  Engr. Glenn C. Virrey

Character Reference

Ms. Heideliza B. Mauricio, Chief
Human Resource and Admin Section, DPWH-MNDEO
mndeodpwh@gmail.com

Engr. Glenn C. Virrey, ECT Faculty, ECE
ECE Department, TUP Manila
glenncalvin_virrey@tup.edu.ph

I hereby declare that all the information given above is true and correct to the best of my knowledge. All the information shared in the resume is correct, and I take full responsibility for its correctness.

Cruz, Jireh Dawn A.
Applicant

Jericho D. Barrios

jericho.barrios18@gmail.com

+639266849574

Blk 5 Lot 10 Dandelion Rd. Molino Parkhomes Subdivision, Queens Row West, Bacoor, Cavite

Personal Information

Date of Birth:	May 1, 2000
Place of Birth:	Bacoor, Cavite
Nationality:	Filipino
Sex:	Male

Technical Skills

Proficient:	MS Office
Intermediate:	NI Multisim, Design Spark, TinkerCAD, Octave, DesignSpark, Photoshop, Filmora
Beginner:	RStudio, Cisco Packet Tracer, MATLAB, Python, Android Studio, LT Spice, Arduino

Other Skills

- Critical Thinking
- Flexible and Adaptable
- Management Skills
- Can work well independently or with a team.
- Good at Multitasking
- Fast Learner
- Strong Work Ethic

About Me

""*Electronics Engineering graduate seeking to leverage extensive knowledge and skills in the field which deals with passion for data communications, telecommunication and software programming in honing further abilities and picking up field experience based on corporate best practices.*"

Education Background

- **TECHNOLOGICAL UNIVERSITY OF THE PHILIPPINES - MANILA | College**
  Bachelor of Science in Electronics Engineering
  2019- Present
  Ayala Blvd., corner San Marcelino St., Ermita, Manila 1000
- **University of Perpetual Help System DALTA, Las Piñas Campus | Senior High School**
  Science, Technology, Engineering, Math (STEM)
  2017 - 2019
  Alabang–Zapote Rd, Las Piñas
- **Woodridge College | Junior High School**
  2013 - 2017
  Soldiers Hills IV, Molino 6, Bacoor, Cavite
- **Woodridge College | Pre Elementary to Elementary**
  2004 - 2013
  Soldiers Hills IV, Molino 6, Bacoor, Cavite

Affiliations / Certifications

2019 - 2022	**Organization of ECE Students of the Technological University of the Philippines - Manila** Member
2019 - 2021	**INSTITUTE OF ELECTRONICS ENGINEERS OF THE PHILIPPINES, INC.** Member

August 2022 **University of Perpetual Help System DALTA, Las Piñas**
Internship / On-the-Job Training

April 2023 **FORTINET NSE CERTIFICATION PROGRAM**
NSE 1 NETWORK ASSOCIATE

April 2023 **FORTINET NSE CERTIFICATION PROGRAM**
NSE 2 NETWORK ASSOCIATE

May 2023 **FORTINET NSE CERTIFICATION PROGRAM**
NSE 3 NETWORK ASSOCIATE

Seminars Attended

- **DISCOVER THE NEW TRENDS: VIDEO CONFERENCING TOOLS TO INCREASE PRODUCTIVITY**
  July 23, 2020
  DIR. LEO CIPRIANO L. URBIZTONDO JR.
- **THE AGILE ETHOS: Turning Small Increments into Huge Developments**
  June 18, 2022
  Engr. Emman Navalan
- **NAVIGATING SYNTAX SENTIMENTS IN THE TRANSFORMING WORLD: Neural Networks and Natural Language Processing**
  June 18, 2022
  Dr. Charibeth Cheng
- **NEXT GENERATION QUALIFICATION: The Role of Physics of Failure and Artificial Intelligence in Electronics**
  April 4, 2023
  Dr. Michael Pecht
- **UNLEASHING THE POWER OF DATA: SAP Analytics Cloud Workshop**
  April 13, 2023
  Engr. Roy Joseph R. Roberto
- **STEP UP: Paradigmatic Career in Today's Semiconductor Industry**
  April 24, 2023
  Engr. Aaron U. Aquino
- **APP DEV INSIDER: Behind the Scens of Application Development Using Flutter**
  May 4, 2023
  Mr. John Lester Necesito
- **CONNECTING THE UNCONNECTED: Exploring the Potential of LORAWAN in Revolutionizing IOT Connectivity for a Smarter World**
  May 29, 2023
  Mr. Rommel Jay Gadil
- **UNLOCKING THE LIMITLESS: Getting Cloud-Powered with Google Cloud Platform**
  June 2, 2023
  Mr. Juan Miguel Mendoza
- **HACK-PROOF YOUR DIGITAL LIFE: A Beginner's Guide to Information Security**
  June 5, 2023
  Engr. Keshav Das Manalo
- **BUILDING BLOCKS OF IC Design: A Primer for Graduating Electronics Engineering Students**
  June 20, 2023
  Engr. Glenn C. Virrey

Character Reference

Engr. Glenn C. Virrey, ECT Faculty, ECE
Department, Techonological University of the Philippines - Manila 09178707167
glenncalvin_virrey@tup.edu.ph

Engr. Marck Vicmundo , Data Engineer
MA Digital Marketing 09959878053

I hereby declare that all the information given above is true and correct to the best of my knowledge. All the information shared in the resume is correct, and I take full responsibility for its correctness. aragraph text

Barrios, Jericho D.
Applicant

MARIE SHAINA J. SOLIDARIOS

shaina.solidarios@gmail.com
+639309701053/+639955079501
Blk 13 Lot 36 Denmark St. Mandarin Homes Brgy. F. De Castro GMA, Cavite

Personal Information

Date of Birth:	March 2, 2000
Place of Birth:	San Pedro, Laguna
Nationality:	Filipino
Sex:	Female

Technical Skills

Proficient:	MS Office Suite, Canva
Intermediate:	NI Multisim, Design Spark, TinkerCAD, Octave, DesignSpark
Beginner:	RStudio, Cisco Packet Tracer, MATLAB, Python, Android Studio, LT Spice, Arduino

Other Skills

- Basic knowledge about Root Cause Analysis
- Highly determined and dedicated towards work
- Open to new ideas and concepts
- Open to feedbacks
- Detail-oriented
- Well-organized
- Can work independently or as part of a team
- Able to work individually without direct supervision
- Good at multitasking
- Can deal with stressful situations in a calm and professional manner
- Professional attitude and motivational approach to work
- Readiness to learn and eagerness to grow

About Me

""*Electronics Engineering graduate seeking to leverage extensive knowledge and skills in the field in a company position that supports continuous learning while performing necessary tasks."*

Education Background

- **TECHNOLOGICAL UNIVERSITY OF THE PHILIPPINES - MANILA | College**
  Bachelor of Science in Electronics Engineering
  2018- Present
  Ayala Blvd., corner San Marcelino St., Ermita, Manila 1000

- **Philippine Merchant Marine School - Las Piñas (PMMS)| Senior High School**
  Science, Technology, Engineering, Math (STEM)
  2016 - 2018 | With Honors
  Valley Road, Talon Uno, Las Piñas, 1747 Metro Manila

- **Holy Family Academy of GMA Inc. (HFA)| Junior High School**
  2014 - 2016 | Silver Awardee
  Congressional Rd, Poblacion 1, General Mariano Alvarez, 4117 Cavite

- **Academe of St. Jude Thaddeus (ASJT) | Junior High School**
  2012 - 2014 | Most Improved Student
  Lot 40-42, Phase IVC, Blk. 23, Monteverde F. de Castro, GMA Cavite

- **Academe of St. Jude Thaddeus (ASJT) | Pre Elementary to Elementary**
  2003 - 2012 | Loyalty Award
  Lot 40-42, Phase IVC, Blk. 23, Monteverde F. de Castro, GMA Cavite

Affiliations / Certifications

2016 - 2018	**PMMS Supreme Student Government** Peace Officer
2018 - Present	**INSTITUTE OF ELECTRONICS ENGINEERS OF THE PHILIPPINES, INC.** Member

August 2022 **CIRTEK ELECTRONICS CORPORATION**
Internship / On-the-Job Training

May 2023 **FORTINET NSE CERTIFICATION PROGRAM**
NSE 1 NETWORK ASSOCIATE

May 2023 **FORTINET NSE CERTIFICATION PROGRAM**
NSE 2 NETWORK ASSOCIATE

June 2023 **FORTINET NSE CERTIFICATION PROGRAM**
NSE 3 NETWORK ASSOCIATE

Seminars Attended

- **THE AGILE ETHOS: Turning Small Increments into Huge Developments**
  June 18, 2022
  Engr. Emman Navalan
- **NAVIGATING SYNTAX SENTIMENTS IN THE TRANSFORMING WORLD: Neural Networks and Natural Language Processing**
  June 18, 2022
  Dr. Charibeth Cheng
- **FIRE DETECTION AND ALARM SYSTEMS**
  April 24, 2022
- **NEXT LEVEL: Artificial Intelligence Trends in the 21st Century**
  March 12, 2022
  Dr. Ira C. C. Valenzuela-Estropia
- **GLOBAL YOUTH SUMMIT 2018**
  August 2018
- **TechEX: Biomedical Technology 101**
  December 21, 2021
- **NEXT GENERATION QUALIFICATION: The Role of Physics of Failure and Artificial Intelligence in Electronics**
  April 4, 2023
  Dr. Michael Pecht
- **UNLEASHING THE POWER OF DATA: SAP Analytics Cloud Workshop**
  April 13, 2023
  Engr. Roy Joseph R. Roberto
- **STEP UP: Paradigmatic Career in Today's Semiconductor Industry**
  April 24, 2023
  Engr. Aaron U. Aquino
- **APP DEV INSIDER: Behind the Scens of Application Development Using Flutter**
  May 4, 2023
  Mr. John Lester Necesito
- **CONNECTING THE UNCONNECTED: Exploring the Potential of LORAWAN in Revolutionizing IOT Connectivity for a Smarter World**
  May 29, 2023
  Mr. Rommel Jay Gadil
- **UNLOCKING THE LIMITLESS: Getting Cloud-Powered with Google Cloud Platform**
  June 2, 2023
  Mr. Juan Miguel Mendoza
- **HACK-PROOF YOUR DIGITAL LIFE: A Beginner's Guide to Information Security**
  June 5, 2023
  Engr. Keshav Das Manalo
- **BUILDING BLOCKS OF IC Design: A Primer for Graduating Electronics Engineering Students**
  June 20, 2023
  Engr. Glenn C. Virrey

Character Reference

Engr. Glenn C. Virrey, ECT Faculty, ECE
Department, Techonological University of the Philippines - Manila 09178707167
glenncalvin_virrey@tup.edu.ph

Engr. Efren Reynoso , Back End & Process Engineer
Cirtek Electronics Corporation 09912323389
efren.reynoso@cirtek.ph

Engr. Jone Paoulo Beltran , Process Engineer Manager
Cirtek Electronics Corporation
jp.beltran@cirtek.ph

I hereby declare that all the information given above is true and correct to the best of my knowledge. All the information shared in the resume is correct, and I take full responsibility for its correctness. aragraph text

Solidarios, Marie Shaina J.
Applicant

MICHAEL PAUL A. BAUTISTA

bautista.mpa@gmail.com
+639056656338
BLK 1 LT 2 CATTLEYA ST CAMELLA TOWNHOMES BRGY ELIAS ALDANA, LAS PIÑAS CITY

Personal Information

Date of Birth:	November 4, 1999
Place of Birth:	Parañaque City
Nationality:	Filipino
Sex:	Male

Technical Skills

Proficient:	Arduino, Java, Python, MS Office Suite, Canva
Intermediate:	NI Multisim, TinkerCAD, Octave, DesignSpark, PHP, SQL
Beginner:	RStudio, Cisco Packet Tracer, MATLAB, Visual Basic, Android Studio, LT Spice

Other Skills

- Active listening
- Attention to detail
- Continuous Learning
- Critical Thinking
- Empathy and patience
- Multi-tasking
- Problem-solving
- Resourceful
- Strategic Planning
- Team Player

About Me

"Passionate individual with a curiosity for innovation, dedicated to conducting research that pushes the boundaries of technology and contributes to meaningful advancements."

Education Background

- **TECHNOLOGICAL UNIVERSITY OF THE PHILIPPINES - MANILA | College**
  Bachelor of Science in Electronics Engineering
  2018- Present
  Ayala Blvd., corner San Marcelino St., Ermita, Manila 1000
- **TECHNOLOGICAL UNIVERSITY OF THE PHILIPPINES - MANILA | Senior High School**
  Science, Technology, Engineering, Math (STEM)
  2016 - 2018
  Ayala Blvd., corner San Marcelino St., Ermita, Manila 1000
- **St. Rose of Lima (Las Piñas) School Inc. | Junior High School**
  2012 - 2016
  860 Tramo st., Daniel Fajardo (Poblacion), Las Piñas City

Affiliations / Certifications

May 2019 **PhilNITS**
IT PASSPORT (IP) CERTIFICATION

Seminars Attended

- **GLOBAL YOUTH SUMMIT 2018**
  August 2018

- **NEXT GENERATION QUALIFICATION: The Role of Physics of Failure and Artificial Intelligence in Electronics**
  April 4, 2023
  Dr. Michael Pecht

- **UNLEASHING THE POWER OF DATA: SAP Analytics Cloud Workshop**
  April 13, 2023
  Engr. Roy Joseph R. Roberto

- **APP DEV INSIDER: Behind the Scens of Application Development Using Flutter**
  May 4, 2023
  Mr. John Lester Necesito

- **Open RAN Radio Network Planning & Deployment**
  May 20, 2023
  ASIA Open RAN Academy

- **CONNECTING THE UNCONNECTED: Exploring the Potential of LORAWAN in Revolutionizing IOT Connectivity for a Smarter World**
  May 29, 2023
  Mr. Rommel Jay Gadil

- **UNLOCKING THE LIMITLESS: Getting Cloud-Powered with Google Cloud Platform**
  June 2, 2023
  Mr. Juan Miguel Mendoza

- **HACK-PROOF YOUR DIGITAL LIFE: A Beginner's Guide to Information Security**
  June 5, 2023
  Engr. Keshav Das Manalo

- **iLEAP Plus: IP 101 Discovering your IP Rights**
  June 06, 2023

- **Patent Search Seminar**
  June 10, 2023

- **BUILDING BLOCKS OF IC Design: A Primer for Graduating Electronics Engineering Students**
  June 20, 2023
  Engr. Glenn C. Virrey

Character Reference

Engr. Glenn C. Virrey, ECT Faculty, ECE
Department, Techonological University of the Philippines - Manila 09178707167
glenncalvin_virrey@tup.edu.ph

Crizoe L. Rodillo
Mechanical Design Engineer, Samsung Electro-Mechanics Philippines - 09171335268

I hereby declare that all the information given above is true and correct to the best of my knowledge. All the information shared in the resume is correct, and I take full responsibility for its correctness.

Bautista, Michael Paul A.