KIX3001 - Integrated Design Project (IDP) 2

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Final Report

Group No: 13

Carefree Smart Farming System

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CHAPTER 1: ABSTRACT

Smart farming is a new concept as IoT sensors may provide information about the agriculture fields and then act on it based on user input. With the aid of IoT, the user can collect real-time data as well as the condition of the crops from time to time. It's a self-configuring network made up of a variety of devices. The new advances in Smart Farming, which make use of IoT, are slowly but steadily changing the face of traditional agriculture methods, not only by making them more efficient for farmers, but also by reducing crop waste. Our product aims to help people who live in urban areas to plant crops efficiently by applying automated systems and IoT. It provides live data such as soil moisture, soil temperature, and fertilizer level. Besides, this system will provide carefree and minimum maintenance which the user only needs to refill the fertilizer once a month and when the big water tank is out of water. This system is also enhanced with rain and temperature detection where the user can notice the parameter change through the mobile application. Various electrical components and sensors are installed such as a rain sensor, fertilizer level sensor, temperature sensor, soil moisture sensor, and high-frequency insect sound repeller. The real-time data can be monitored on the Blynk mobile, and this allows the user to manage their crops in a proper manner. A carefree system is provided as the user can monitor the crop's condition from anywhere and with less effort.

CHAPTER 2: INTRODUCTION

In Malaysia, agriculture, fishery, and forestry sectors employ around 10% of Malaysia’s workforce and contribute about 8% of the country’s y’s GDP (Gross Domestic Product). Agriculture is the most diverse economic sector and plays a critical part in a country's overall economic development. Technological improvements in agriculture will ensure that specific farming tasks become more competent. From the statistics, we can see that the agriculture sector plays a vital role in our country’s economics. A rise in population growth is accompanied by an increase in food production demand. According to the FAO (Food and Agriculture Organization), the global population will reach 9.73 billion by 2050, and will continue to rise until it reaches 11.2 billion by 2100. Many obstacles obstruct agricultural development, resulting in lower crop productivity, such as soil salinity in arid climates. Furthermore, the climate has an impact on crop quantity and quality, as well as increasing soil sensitivity to desertification. As a result, using new technologies to improve the agriculture sector is a critical issue for those countries' national economies. From planting and watering to crop health and harvesting, technological improvements may help in almost every area of farming. It's only natural that IoT, linked devices, and automation will make their way into agriculture and, as a result, vastly improve many aspects of farming. This is the drive behind the development of Smart Farming technologies.

The main difference between traditional and urban agriculture is that food production in urban areas takes up less space, consumes less water, utilizes more sustainable packaging and produces fewer greenhouse gases. Typically, urban agriculture uses intensive production methods, frequently reusing natural resources and urban wastes, to produce a diverse array of land-, water-, and air-based fauna and flora that contribute to the individual, household, and community's food security, health, livelihood, and environment.

Agriculture's future will include not only farmers but also technology players. This will be particularly important in cities, where space is limited but demand for fresh food is great.

However, the main concerns for urban agriculture are the limited lateral spaces, loss and damage of crops from birds and rodents, contaminated soils and high costs.

Thus, to solve all these problems, in our project, we intend to design a system that can help to reduce spaces, labour as well as water quality for the farmer to increase their yield and crop quality. The title of our project is Carefree Smart Farming System. In our product, automation is added as it can create a carefree smart farming system. Several subsystems such as a microcontroller system are used for the sensor control and the interface. Also, cloud services and data analytics platforms are provided in order to monitor the nutrient supply.

As a whole system, a few sensors are used such as rain sensor, fertilizer level sensor, soil moisture sensor and soil temperature sensor. When the soil moisture are detected to be lower than 45%, the relay will switch on the pump and pull up the water module. Also, our system will update the real time data for the soil moisture. Thus, the user can monitor the condition of crops by using an application called Blynk. Pak Choi are chosen as our crop. It is a leaf vegetable plant that has a high economic value. Also, it is easier to handle and easier to grow. Peat moss is used as the growing medium for our plants.

Smart farming is a new concept that refers to managing farms with IoT, robots, drones, and artificial intelligence (AI) to raise the number and quality of goods while reducing the amount of human labour required for production. The Internet of Things (IoT) in Smart Farming technology is the notion of integrating linked smart machines and sensors on farms to make farming processes data-driven and data-enabled. Thus, we believe that by having our product, we can help the residents in urban areas or high-rise residential to grow their plants in an effective way.

2.1 Background

Based on the United Nations, the world population is predicted to grow from 6.9 billion in 2010 to 9.1 billion in 2050. By 2050, food demand is predicted to increase by 70%. The main challenge facing the agricultural sector is not so much growing 70% more food in 40 years, but making 70% more food available on the plate." And there are more challenges brought by climate change in that sector. A profound change of the global food and agriculture system is needed if we are to nourish the more than 690 million people who are hungry today – and the additional 2 billion people the world will have by 2050. Increasing agricultural productivity and sustainable food production is crucial to help alleviate the perils of hunger.

As what is available in traditional agriculture, farmers basically need to monitor their plant, put nutrients, and water their crops manually. Eventually, there are quite a lot of sellers promoting low-cost piping that help distribute water in a very small amount for a certain duration to perform a mock-up plant water consumption control. Although they have a piping system that can ease them to water the plant, they still need to switch on/ off the pipe and can't leave their farm for a very long period. Thus, by having this system, the planting system became automatic, and less manpower is needed to take care of the plant.

Internet of Things (IoT) consists of two words which are Internet and Things. The term "Things" in the Internet of Things refers to numerous IoT devices with distinct identities and the ability to perform remote sensing, actuation, and live monitoring of specific types of data.

IoT devices can also exchange data in real time with other connected devices and applications, either directly or indirectly, as well as collect data from other devices, process it, and send it to other servers. The other term is "Internet," which is described as a global communication network that connects billions of computers around the world to enable information sharing. While smart farming refers to a set of solutions that, mostly through the use of information and communication technologies, boost agricultural efficiency. We can relate both IoT and smart farming together as data collection, analysis, and precise application enable for increased yields while reducing losses.

Urban farming is the technique of producing, processing and distributing food in or around the urban settings. Urban farming involves cropping on the roofs of buildings or even indoors, and many urban farmers may lack professional farming skills. Many important farming processes, however, can be automated with information technology such as cloud services, requiring minimal human participation in monitoring and operating sensors. In Malaysia, the government and urban residents have lauded the potential of urban farming, which can help to supplement income, create jobs, and serve as a garbage sink.

In urban design, urban farms can take the form of conventional modest outdoor community gardens or futuristic vertical farms. These futuristic farms can be built in a variety of ways, but the majority of them have rows of racks lined with plants that are rooted in nutrient-rich soil, water, or just air. There are some successful examples of urban farming like Sky Green in Singapore and the urban garden in Kreuzberg's Prinzessinnengarten, near the Berlin Wall, which grows a variety of vegetables and fruits in rice sacks, recycled Tetra packs, and plastic crates.

Next, we will discuss the benefits of urban farming. First, urban farming enhances food security. Food security refers to having enough sustainable food to feed yourself and your family. This is a serious problem for many families all around the world. However, urban gardening is a viable answer to this issue. Producing your own food and cultivating your own vegetables and herbs on undeveloped land are two ways that the urban poor might pay their own way. In fact, urban farmers can sell some of their harvest and keep the remainder.

Urban farming can also improve the efficient use of land. Fertile lands are disappearing every day as a result of rising population and enormous urbanisation. Urban farming could be a viable option for maximising the amount of land available to feed people. Rooftop gardens, for example, not only save space but also give an abundance of fresh vegetables. Furthermore, this is the type of area that would otherwise be unused. Vertical gardens, in fact, can be created virtually anywhere, including indoors.

Urban farming is a guaranteed way to reduce the carbon footprint of mass production and distribution. It also aims to make healthy food more inexpensive and accessible to the general public.

CHAPTER 3: MOTIVATION/ RATIONALE AND GOAL

3.1 Analysis of needs

There are a few reasons why the farmers need this type of system to be implemented in their home. It is because of the: a) inefficient nutrient and water supply, b) lack of monitoring system implementation in the farm and c) lack of plant spacing. The first one is the inefficient nutrient and water supply. We found that these 3 things are interfering with the growth of the plants. The first problem is inefficient nutrient and water supply. Yes, there are a lot of modern farmers that use automated systems such as automated watering systems, but it is not based on the real-time status of the plants. Mostly the automated system today is based on time where the system will supply the things needed by the crop according to the fixed pre-set time range by farmers regardless of the moisture and fertility of the soil. Next is lack of monitoring system implementation in the farm. Traditionally, farmers struggle to monitor the amount of water and nutrients of the soil from observation only since it is based on their experience and no scientific baseline can be referred to. Plus, this is very crucial for the plants as these 2 main elements that contribute most in developing a healthy plant. Lastly, the lack of plant spacing. As we all know, if there isn't enough space between plants in the garden, nutrients, water, and light are sucked out or used too quickly, causing the plants to suffer. Plant spacing issues can result in poor growth, low yields, and general plant health issues. Thus, this system can help to reduce the space needed for planting especially for those in urban area and high rise residential.

3.2 Justification/Argument on Need of Project

As we know, most farmers in Malaysia are still applying the traditional way of farming where the farmers are using the manpower to plant, water, and fertilize the plants frequently where it is found that it is less efficient economically as return from the selling of the crop is not worth the labor cost investment. Also, considering human error, sometimes the human will miss the routine of caring for their crops because of their carelessness and tiredness or due to any other random factors. Also, the lack of space will cause the plants' quality to be minimized. The food security problem has become one of the concerns in our country and the price of vegetables are getting increased from time to time. Thus, we came out with an idea to reduce the possibility of this problem happening. A carefree smart farming system is able to control the number of nutrients needed. To justify and prove the need for this project, we have carried out a survey and from there, we found some customer needs and hence we form the customer statements.

CHAPTER 4: OBJECTIVES

- To build a system that capable of growing crops efficiently.
- To implement the IoT concept to obtain real time data and control the system by applying some specific sensors, software and hardware.
- To develop a carefree planting system for people that are busy with their daily activities.

CHAPTER 5: BACKGROUND/LITERATURE

5.1 Product Classification

The Smart Farming system involved several subsystems such as microcontroller system for sensor control and interface, interconnected with cloud services along with data analytics platform through Wi-Fi module. Our aim is to equip high-rise residential resident and small urban farmers with an affordable smart farming system to improve crop growth monitoring, irrigating and nutrient supply

5.2 Review on Current Status

According to DigitalEdge.com, the agricultural sector in Malaysia is dominated by smallholding farmers. This type of farmer is facing many challenges to survive. The challenges are low productivity and crop yield. Why does this problem happen? It is because of the lack of manpower. The farmers can overcome this problem by applying the smart farming system to their farms because it can save huge costs in the long run. Besides that, according to New Straits Times, many farmers are affected by soil erosion, and water and air pollution. One of the farmers said that he lost all of his crops which resulted in the loss of capital of around RM 100, 000. He said that all of the crops that are going to be harvested by the end of January are gone and yet he has not received any government aid. This shows how bad soil erosion, water and air pollution can bring to farmers and how underrated farmers in Malaysia are.

5.3 Existing Solution

In Malaysia, there are very few projects are focusing in the smart farming system. One of the developed platforms is SM4RT T4NI. This platform continued the effort of Malaysia government to expand its digital footprint. SM4RT T4NI is packed with automation feature to help the farmer to increase their efficiency, productivity and yield with cutting edge solution. The feature includes to ensure the real time pH, weather monitoring, pest control and crop monitoring. All this feature can be successful by getting helps from IoT connectivity. In addition, this platform is created with user-friendly and convenient dashboard to allow all farmer regardless of their education background to handle the system. For expert user, they also allow to customize and do some modification to meet their needs depending on their crop type. This platform also offers their user to upgrade with some enhanced new feature such as the implementation of drone technology. However, there are lot more type of smart farming all around the world. Different type of smart farming is shown in the table below.

Table 1: Existing Solution of Smart Farming

No	Existing Solution	Description	Pros	Cons
1	IoT-based remote sensing	Use different type of sensors such as weather station. This weather station is placed on the farms to observed and measure data. As example, the data that can be collected is light, humidity, and temperature.	• Easy to setup • Low maintenance	• Difficult to detect if the sensors is malfunction.
2	Computer Imaging	This system was designed with image detection by using the camera sensors. These sensors are	• Easy monitoring. • Accurate result	• High installation cost but cheaper than

		placed at different position on farm. The captured image will undergo digital image processing to get useful information from it.	• Less maintenance.	drone system. • Image processing require a database • Need fertilize and water the plant manually.
3	Agricultural drone	For this system, camera sensors are installed at the drone for imaging, mapping and survey. The measured data are crop health, irrigating, spraying and plant counting.	• Easy monitoring • GPS (Global Positioning System) tracking to detect drone location.	• Manual handling • less battery life around 40 to 30 minutes

5.4 Patents

5.4.1 Search Keyword:

1. Smart AND farming

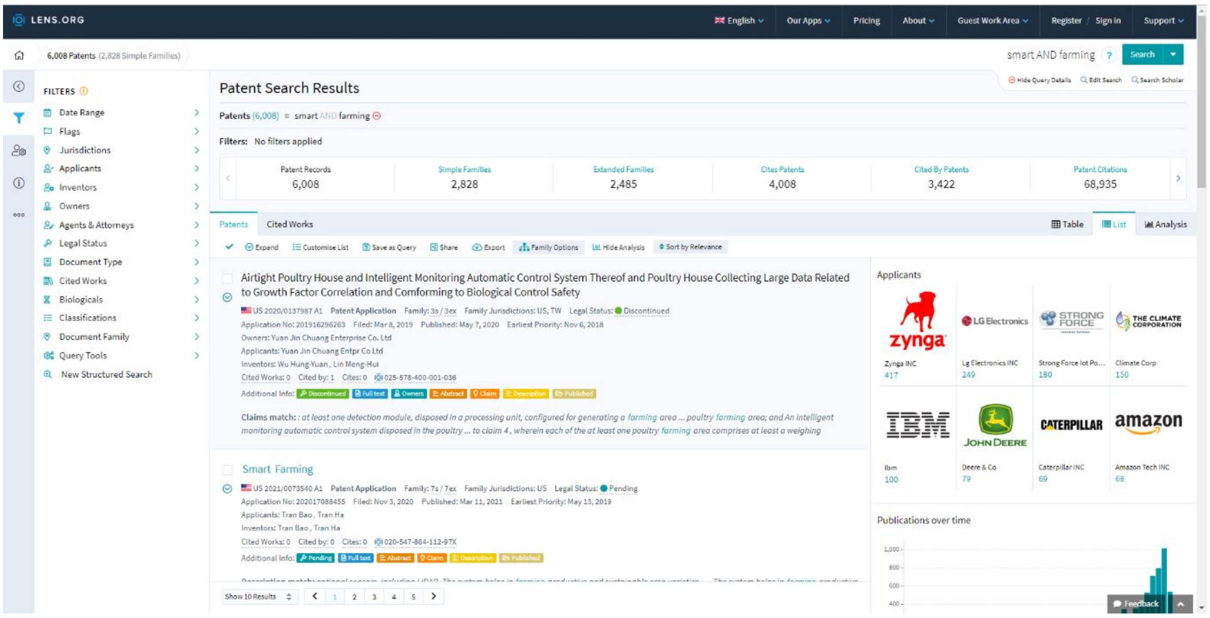


Figure 1: Keyword search of "smart AND farming"

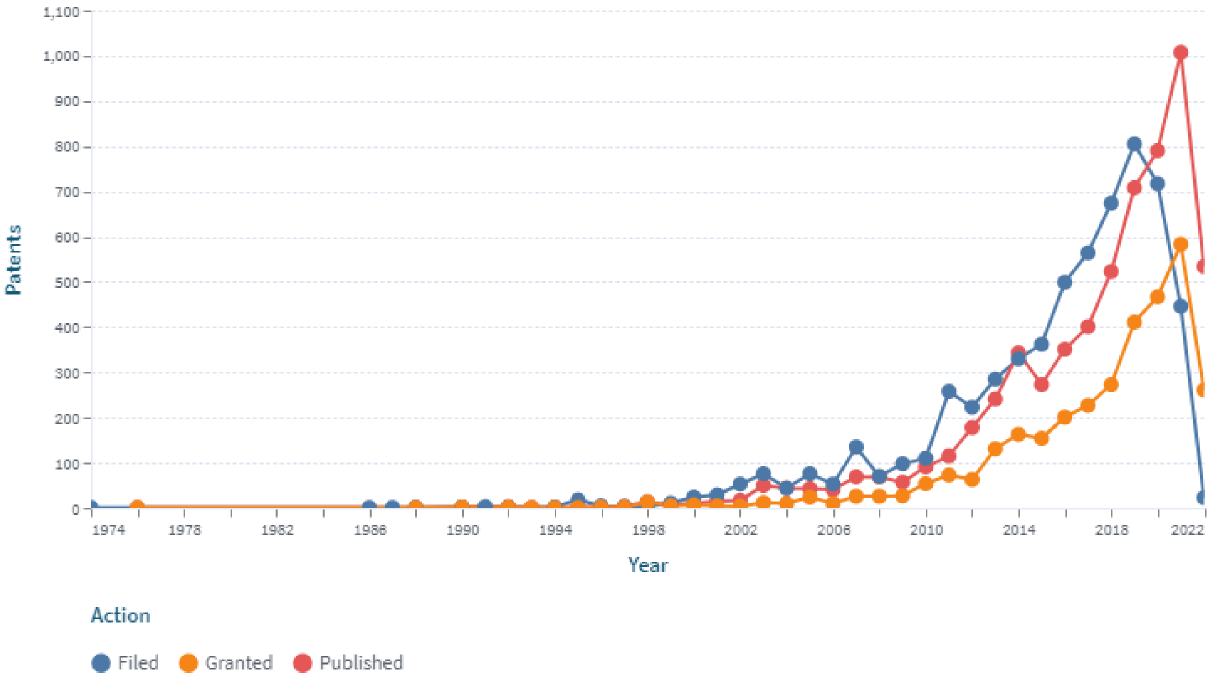


Figure 2: Patent documents by published filed and granted date

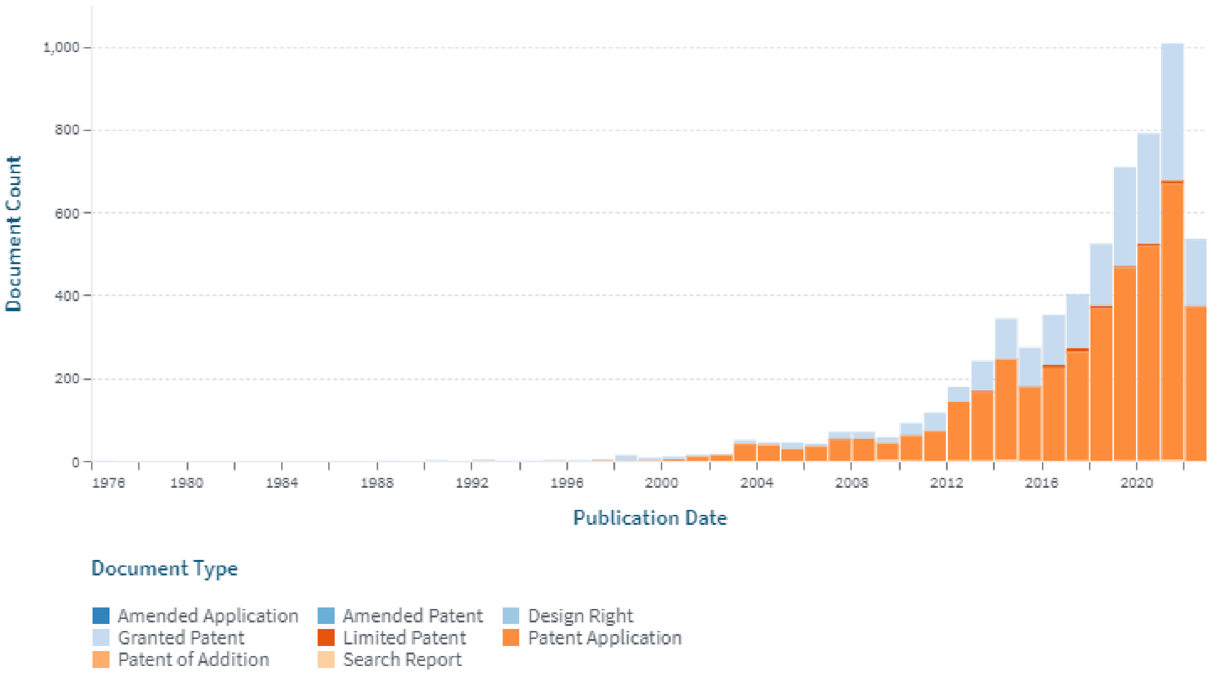


Figure 3: Patent document over time for "smart AND farming" keyword

2. Iot AND farming

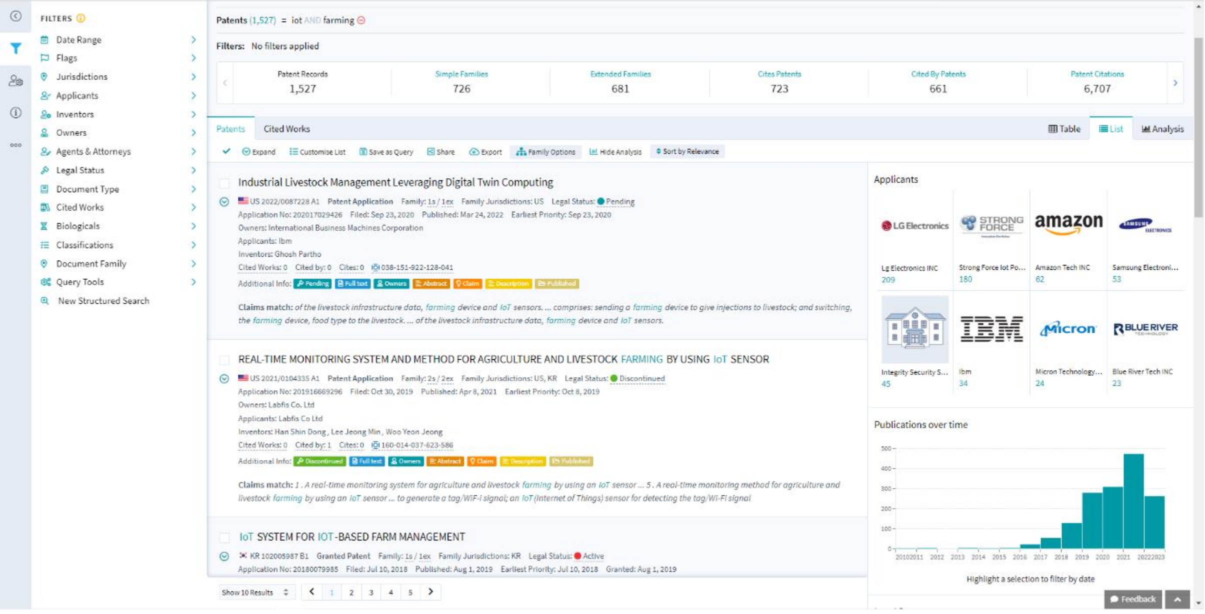


Figure 4:Keyword search of "iot AND farming"

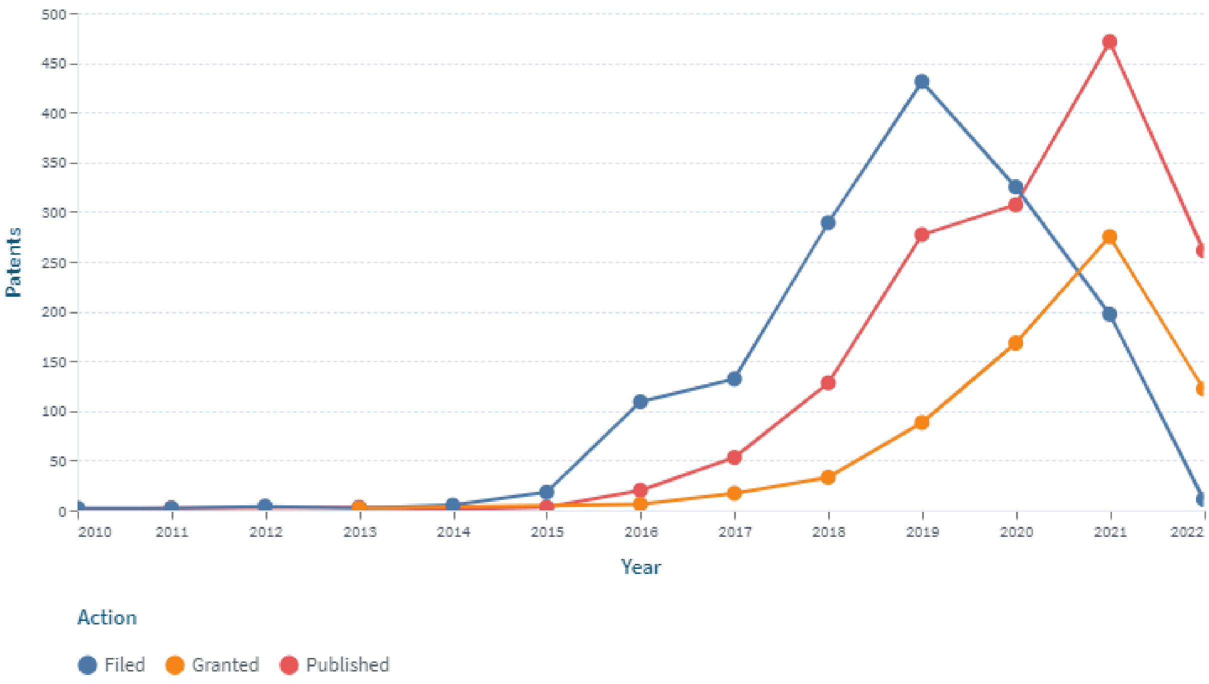


Figure 5: Patent document over time for "iot AND farming" keyword

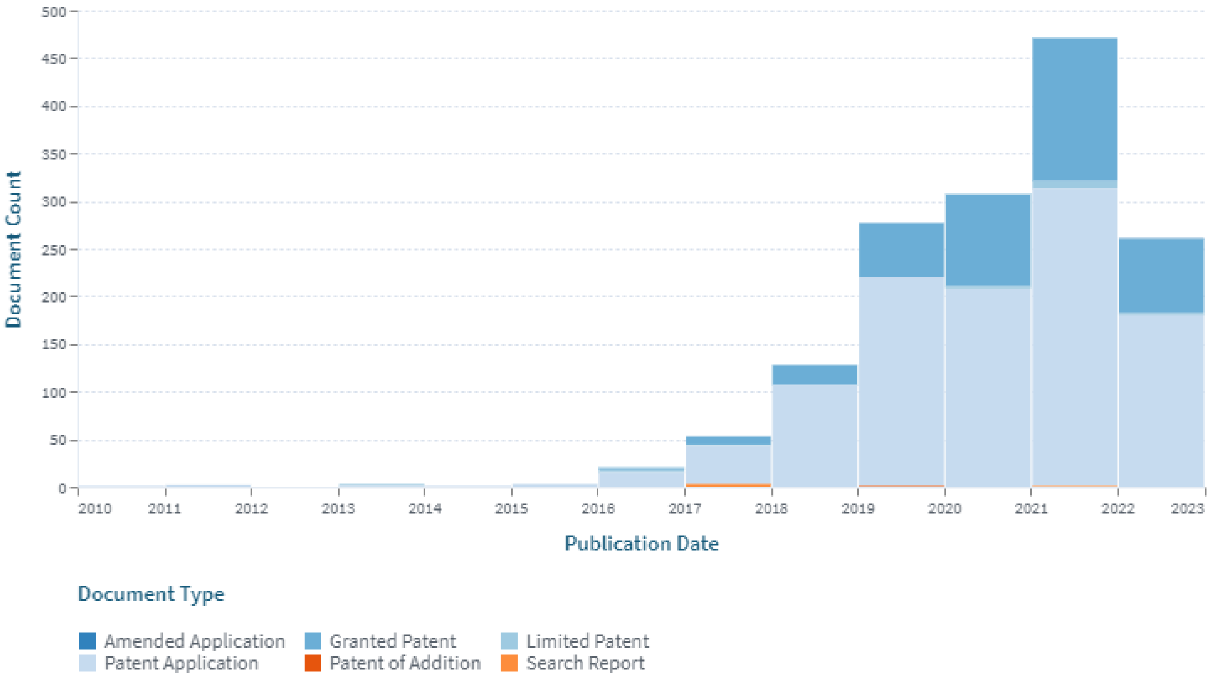


Figure 6:Patent documents by published filed and granted date

3. Iot AND agriculture

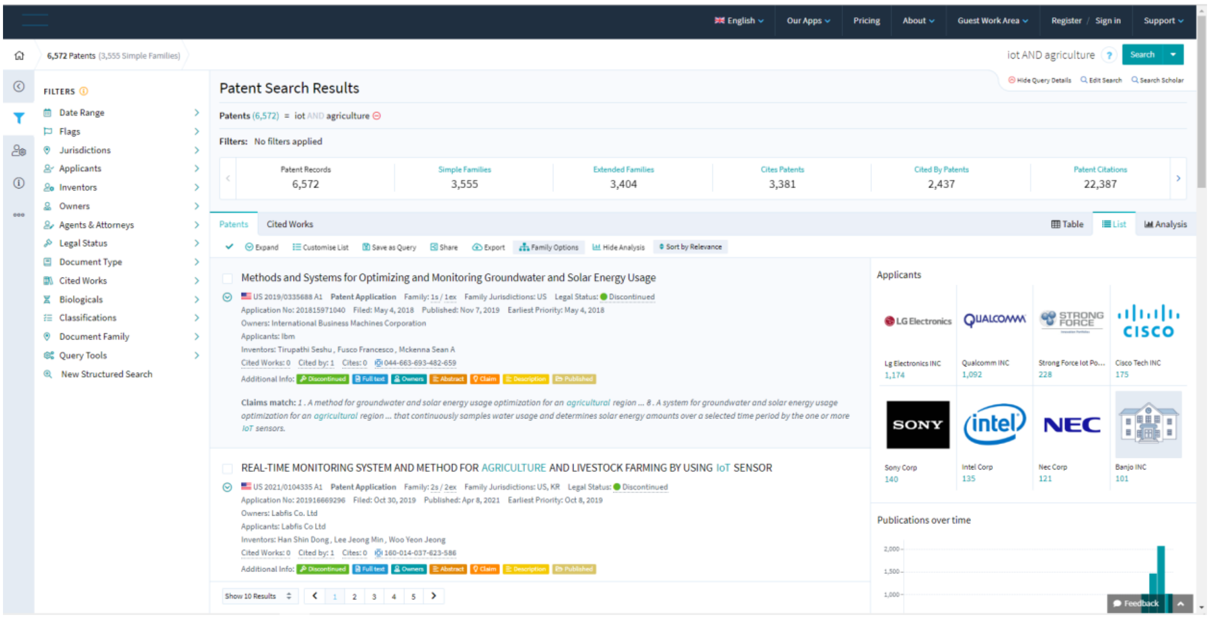


Figure 7:Keyword search of "iot AND agriculture"

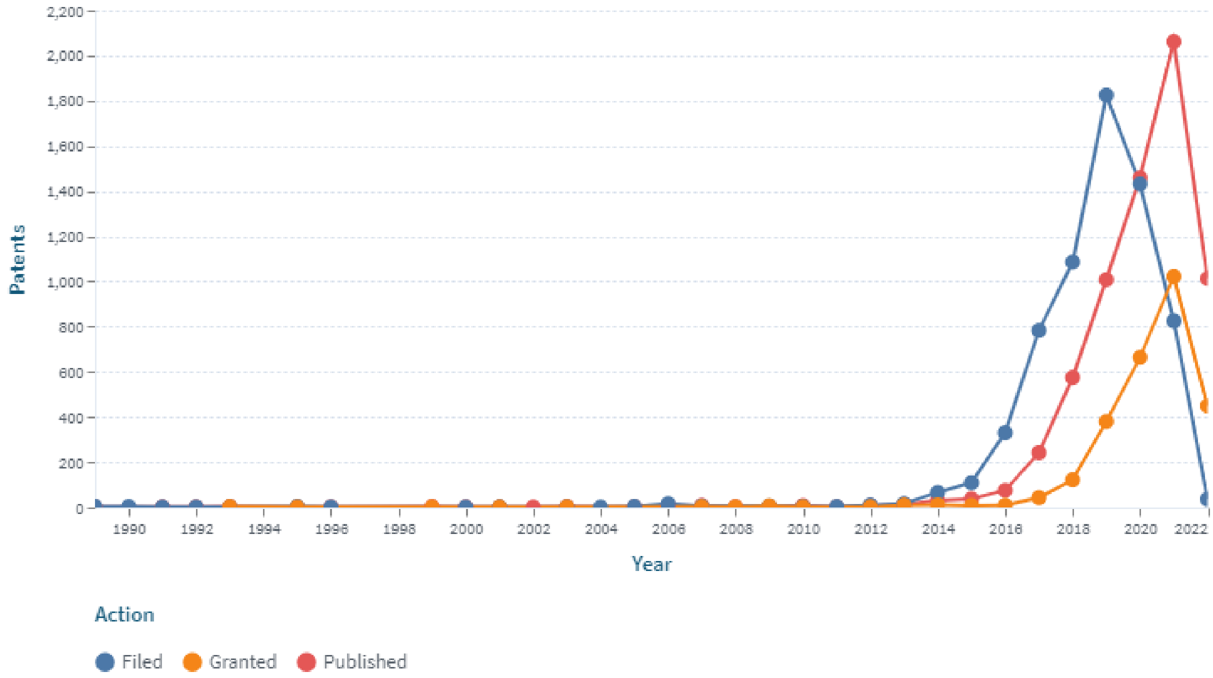


Figure 8: Patent documents by published filed and granted date

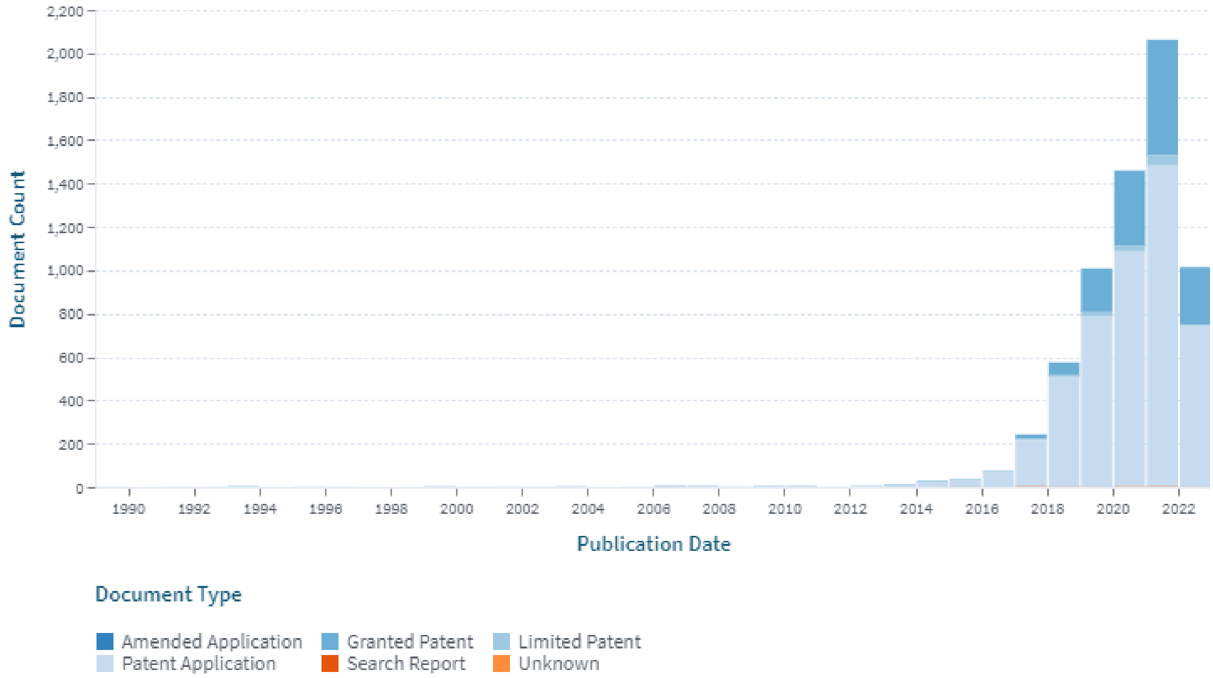


Figure 9:Patent document over time for "iot AND farming" keyword

5.4.2 Mode of Background/ Literature Research:

Literature or Articles search:

- Web of Science
- Google Scholar
- Science Direct

Patent search

- Lens.org

5.4.3 List of useful articles:

1. Smart Farming Systems using sensors
https://ieeexplore.ieee.org/document/8273719 DOI: 10.1109/TIAR.2017.8273719

2. Implement smart farm with IoT technology
https://ieeexplore.ieee.org/document/8323908 DOI: 10.23919/ICACT.2018.8323908

3. Smart Hydroponic Lettuce Farm using Internet of Things
https://ieeexplore.ieee.org/document/8426141 DOI: 10.1109/KST.2018.8426141

4. Advanced energy consumption system for smart farm based on reactive energy utilization technologies
https://www.sciencedirect.com/science/article/abs/pii/S0195925520307745
DOI:10.1016/j.eiar.2020.106496

5. Sensors Control of Smart Farm System Using Gateway Based on Raspberry Pi
https://www.researchgate.net/publication/316995316_Sensors_Control_of_Smart_Farm_Syste m_Using_Gateway_Based_on_Raspberry_Pi
DOI:10.1166/asl.2017.8639

6. IoT Architecture based on Information Flow Diagram for Vermiculture Smart Farming Kit
https://www.researchgate.net/publication/347284032_IoT_Architecture_based_on_Information_ Flow_Diagram_for_Vermiculture_Smart_Farming_Kit
DOI:10.18421/TEM94-03

7. IoT and data interoperability in agriculture: A case study on the gaiasense (TM) smart farming solution
https://www.researchgate.net/publication/333853181_IoT_and_data_interoperability_in_agricult ure_A_case_study_on_the_gaiasense_TM_smart_farming_solution
DOI:10.1109/GIOTS.2019.8766423

8. Low-cost IoT+ML design for smart farming with multiple applications
https://ieeexplore.ieee.org/document/8944791 DOI: 10.1109/ICCCNT45670.2019.8944791

9. Smart Board for Precision Farming Using Wireless Sensor Network
https://ieeexplore.ieee.org/document/8644215 DOI: 10.1109/ICREST.2019.8644215

10. Making sense in the cloud: Farm advisory services in a smart farming future
https://www.researchgate.net/publication/332726925_Making_sense_in_the_cloud_Farm_advis ory_services_in_a_smart_farming_future
DOI:10.1016/j.njas.2019.04.004

5.4.4 List of related patents:

1. Hong, X. U. (2017). SMART CONTROL/IOT SYSTEM FOR AGRICULTURE ENVIRONMENT CONTROL. US (United States), HONG XU.
   US 2017/0127622 A1 - smart control/iot system for agriculture environment control | The Lens
   Application No: 2015149X37748

2. Sauder, D., et al. (2021). AGRICULTURAL DATA ANALYSIS. US, CLIMATE CORP. US 2021/0015024 A1 - Agricultural Data Analysis | The Lens
   Application No: 202017063555

3. Chong Suk, S. (2018). FARMING MANAGEMENT SYSTEM. WO, GREENPHYTO PTE LTD.
   WO 2018/136008 A1 - Farming Management System | The Lens
   Application No: 2018050033

4. Perry David, P., et al. (2019). MACHINE LEARNING IN AGRICULTURAL PLANTING, GROWING, AND HARVESTING CONTEXTS. WO, INDIGO AG INC. WO 2019/032648 A1 - Machine Learning in Agricultural Planting, Growing, and Harvesting Contexts | The Lens
   Application No: 2018045719

5. Tran, B. A. O. and H. A. Tran (2021). SMART FARMING. US, TRAN BAO TRAN HA. US 2021/0073540 A1 - smart farming | The Lens
   Application No: 202017088455

6. Genty Nicholas, R. and M. J. Dominic John (2021). AI-POWERED AUTONOMOUS PLANT- GROWTH OPTIMIZATION SYSTEM THAT AUTOMATICALLY ADJUSTS INPUT VARIABLES TO YIELD DESIRED HARVEST TRAITS. US, AGEYE TECH INC. US 2021/0027057 A1 - Ai-Powered Autonomous Plant-Growth Optimization System That Automatically Adjusts Input Variables to Yield Desired Harvest Traits | The Lens
   Application No:202017068016

7. Akhtar, S. (2020). Integrated IoT (Internet of Things) system solution for smart agriculture management. US, AKHTAR SABRINA
   US 10728336 B2 - Integrated IoT (Internet of Things) system solution for smart agriculture management | The Lens.
   Application No: 201715451420

5.5 Research Gap and Novelty

Smart farming has the ability to produce more productive and sustainable agricultural production through a more precise and resource-efficient method. However, although up to 80% of farmers in the United States utilize some form of SFT, only 24% of farmers in Europe do. However, there are some issues that have not been clarified or investigated in the field of research. Thus, there are some limitations to previous research.

Adapted from (A.NayyarV.Puri, 2016), [10] The author investigates about the IoT based smart sensors agriculture stick for live temperature and moisture monitoring by using Arduino, solar technology and cloud computing. In the study, the smart farming system was implemented to increase the overall yield and quality of the products. Also, this product is tested on the Live Agriculture Fields and results in high accuracy over 98% in the datafeed. However, the data regarding the pest control as well as the GPS module of the product are not focused in the study. Thus, in our smart farming system, we allocate a buzzer among the crops in order to prevent the birds or insects to eat the crops.

Adapted from Ja (Doshi, Patel, & Bharti, 2019), [11]

The authors are investigating on how to optimize the monitoring farming conditions by using IoT in the smart farming system. The product designed will assist the farmers by getting the live data of the temperature, humidity, UV index, IR and soil moisture thus helping them in increasing the crop yields and optimize the usage of resources. In this paper, the authors use 3 different mediums to notify the farmers which are LEDs visual alert, the Blynk mobile app and the small buzzer. However, the authors mention that they couldn't construct more prototypes due to funding constraints, but in big farmlands with a variety of crops, farmers can install numerous prototypes like this that will be in a local network, connected via Bluetooth, and have a single main node that will gather data and upload it to the cloud. Making this entire network of nodes that will be able to make decisions on its own and activate the necessary procedures to neutralise that circumstance in the real IoT sense and with the help of artificial intelligence. A network in which each component can think independently and retrieve data from the cloud to improve their decisions on the fly using data mining methods. Thus, in this case, we will more focus on the collection of real time data using the cloud platform so that the user is alert with the crops condition from time to time.

Adapted from (Sowmya.C.L., Rashmi.N, & Kumar.K.P, 2021), [12]

In this paper, the authors developed a smart agriculture system with the aid of IoT to monitor the temperature, level of water and soil moisture. Also, it can monitor the movement if there is any threat that might destroy the crops in the field. After the hardware has been built to meet changing needs and technologies, the software must be updated. The modified hardware is referred to as a new software version. This new version must be tested to ensure that the changes made in the previous version are implemented correctly and do not introduce defects in other parts of the software. This is required because changing one component of the hardware can have unintended consequences in other parts of the hardware. However, the condition for the testing works well in ideal conditions. Further improvement can be made when the conditions are not ideal.

CHAPTER 6: RESEARCH METHODOLOGY/ PROJECT DESIGN

6.1 Project Methodology and Protocol

6.1.1 Customer Need Survey

A remote interview is done through the help of Google Form to survey and collect relevant data from customers. Different types of questions are set in the forms, some with close ended multiple-choice questions while some is open ended question. The google form link is distributed through Whatsapp, Facebook and Instagram as the main social media platform.

Link to the Google Form: https://forms.gle/KqYUGRGNp54QNJLr5

6.1.2 Customer Survey Population

The main target of our questionnaire is the people who are living in urban areas who are planting crops inside or around their house traditionally or those who have applied smart farming but have comments for improvement on the current system. The Google Form is also distributed to common people that do minor farming as a hobby to get the frame concept of smart farming system in their mind as a brainstorming idea so that our end delivery could be more easily acceptable by the public since it is brainstormed and built based on what they anticipated.

6.1.3 Market Research

6.1.3.1 Interview Questions

Table 2:List of Questions

No	Questions
1	Name / Nama
2	Age / Umur
3	Gender / Jantina
4	Phone Number / Nombor Telefon
5	What area are you living in? / Anda tinggal di Kawasan mana?
6	What is the type of the plants that you are planting now? / Apakah jenis tumbuhan yang anda sedang tanam sekarang?
7	It is very difficult to ensure the plants grow well. / Sangat susah untuk memastikan tanaman tumbuh dengan baik.
8	What are the challenges in order to ensure the plants grow well? / Apakah cabaran dalam memastikan tanaman anda tumbuh dengan baik?
9	Please state what the challenges are if your answer is 'Others'. / Sila nyatakan jika jawapan anda ialah 'Lain-lain'
10	How many times you water your plants daily? / Berapa kali anda siram pokok setiap hari?
11	Do you ever forget or be late to water your plant? / Pernahkah anda terlupa atau terlambat untuk menyiram tanaman anda?

12	Do you agree that there is water wasted during watering plant process? / Adakah anda setuju bahawa terdapat air yang dibazirkan semasa proses penyiraman tanaman?
13	Do you agree that excess amount of nutrient may cause harm to plants? / Adakah anda setuju bahawa jumlah nutrien perosak yang berlebihan membahayakan tanaman?
14	Do you think smart farming concept is suitable to be applied in urban areas? / Adakah anda bependapat konsep Pertanian pintar sesuai untuk diimplementasikan di kawasan bandar?
15	Based on your knowledge, the extent of the use of hydroponic crops in the agricultural industry? / Berdasarkan pengetahuan anda, seluas mana penggunaan tanaman pintar di dalam industri pertanian?
16	From your experience, is there any pests keep disturbing your crops' growth? / Daripada pengalaman anda, adakah terdapat apa-apa haiwan perosak yang mengganggu pertumbuhan tanaman anda?
17	Do you think anti-pests system should be applied in any farm? / Adakah anda berpendapat bahawa system anti haiwan perosak patut digunakan dalam mana-mana ladang?
18	Do you have space for planting crops in your home? / Adakah anda mempunyai ruang untuk penanaman tanaman di rumah anda?
19	Do you have any comment on our product? Please state you opinion below. / Adakah anda mempunyai apa-apa komen berkenaan produk kami? Jika ada sila nyatakan di bawah.

6.1.3.2 Detailed Customer Need Statement

1. Most of the interviewees live in urban areas.
2. All the interviewees agreed that it is very difficult to ensure the plants to grow well.
3. Most of the interviewees agreed that ensuring the plants to get enough water to grow is difficult. Others agreed that ensuring the plants to get enough nutrients and maintaining the optimum soil pH all the time is difficult.
4. Most of the interviewees always forget or late to water their plants.
5. The interviewees believed that there are some of the waters wasted during watering plant process
6. Most of the interviewees already have some knowledges on Smart farming concept.
7. Some of the interviewees know nothing on Smart Farming concept.
8. Most of the interviewees said that the Smart Farming concept is suitable to be implemented in urban areas.
9. 60% of the interviewees stated that they knew that the Hydroponic Farming concept has been already widely used in industry
10. 20% of the others respectively knew a bit and one more group knew nothing about Hydronic Farming concept has been implemented in industry.

11. The interviewees stated that they have experienced disturbance from the pests on their crops.
12. The interviewees stated that anti-pest’s system should be implemented in all farms.
13. 53.3% of the interviewees have very little space for planting crops at their home.
14. 40% of the respondent don’t have any space for planting their crop at home.
15. Interviewees discovered few types of pests disturbing their plant growth which are Aphid, Mealy Bug, Scale Insect and Whitefly.

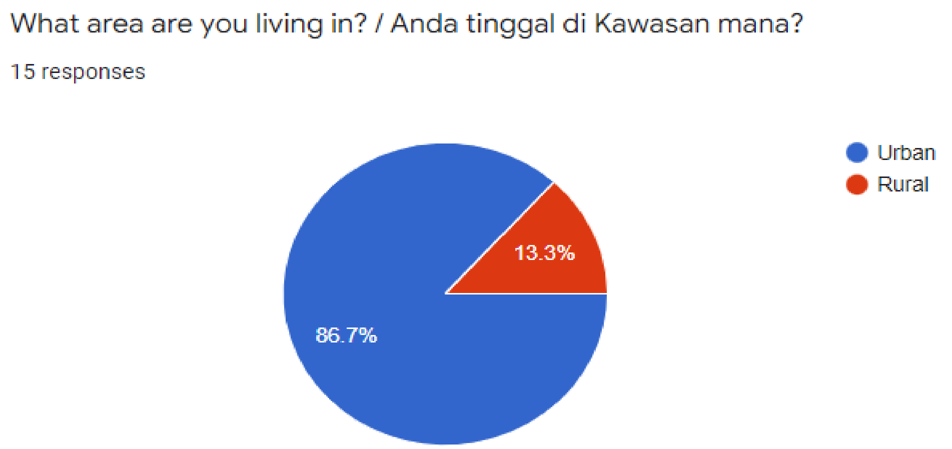


Figure 10:Survey response 1

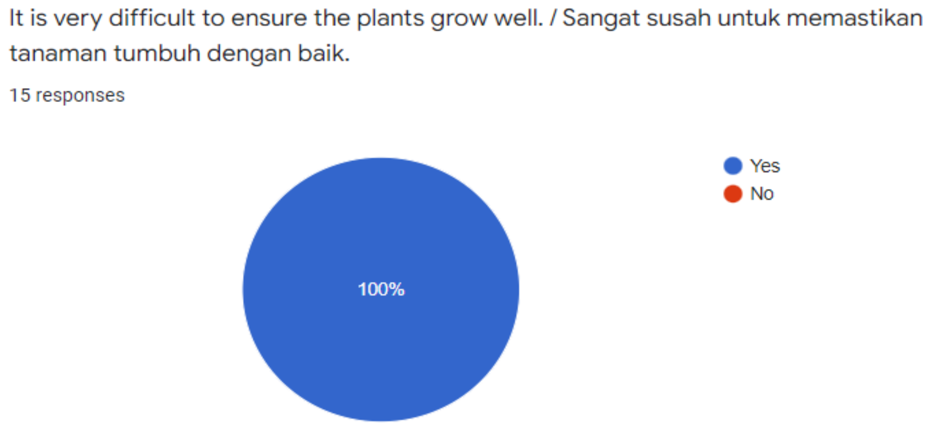


Figure 11:Survey response 2

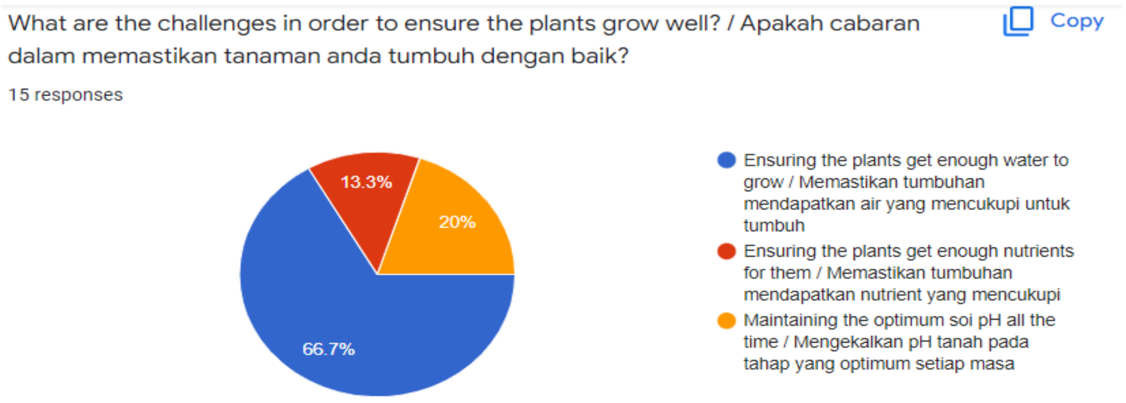


Figure 12:Survey response 3

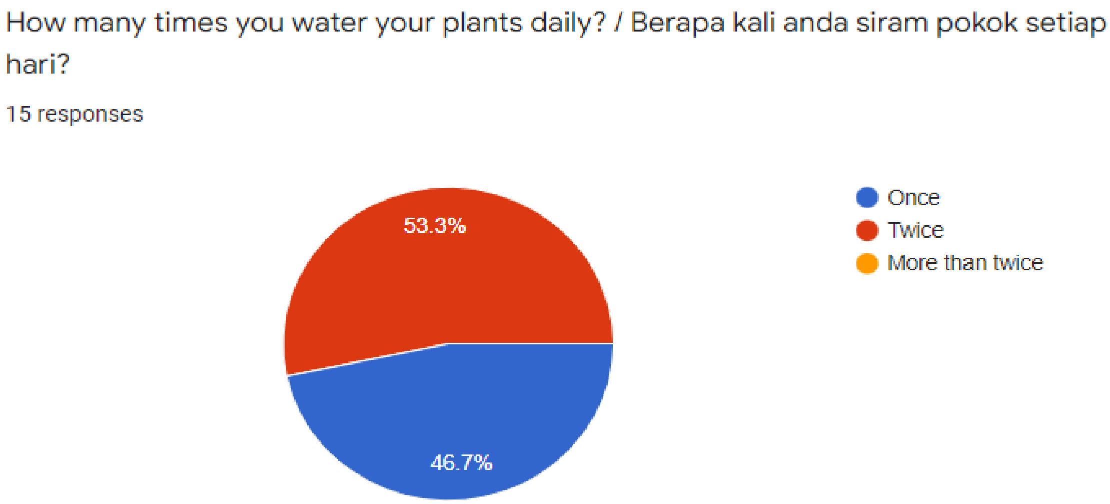


Figure 13:Survey response 4

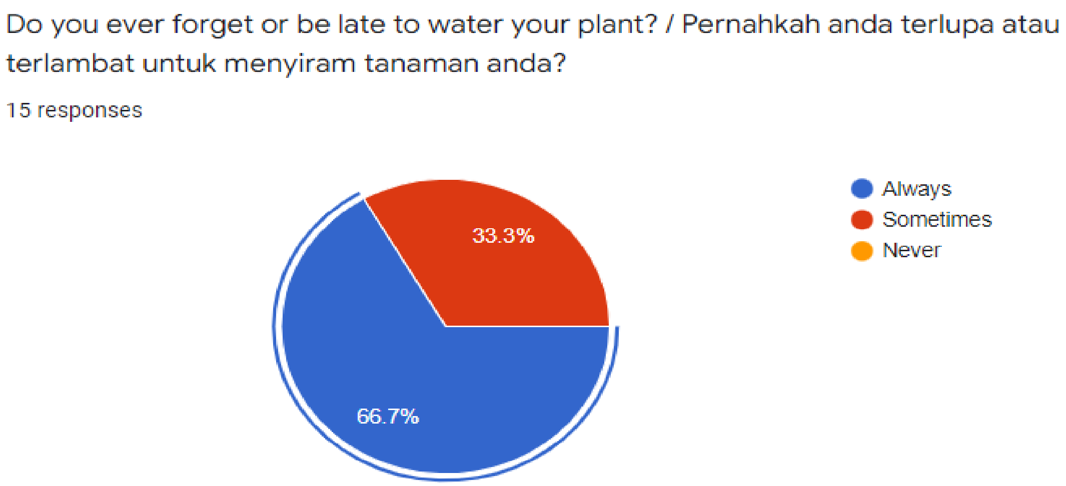


Figure 14: Survey response 5

Do you agree that there is water wasted during watering plant process? / Adakah anda setuju bahawa terdapat air yang dibazirkan semasa proses penyiraman tanaman?

15 responses

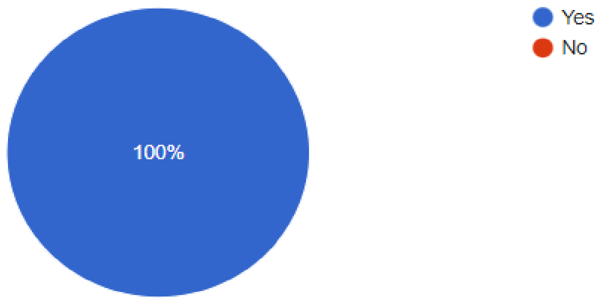


Figure 15:Survey response 6

Do you agree that excess amount of nutrient may cause harm to plants? / Adakah anda setuju bahawa jumlah nutrien perosak yang berlebihan membahayakan tanaman?

15 responses

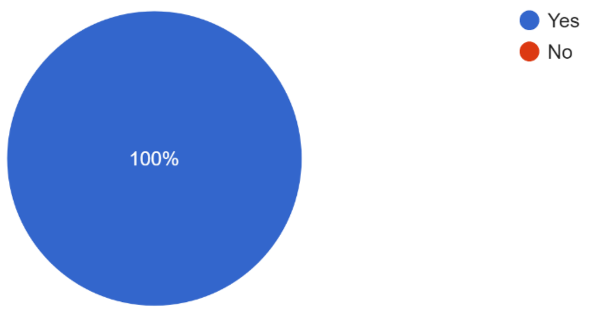


Figure 16: Survey response 7

From your experience, is there any pests keep disturbing your crops' growth? / Daripada pengalaman anda, adakah terdapat apa-apa [illegible] yang mengganggu pertumbuhan tanaman anda?

15 responses

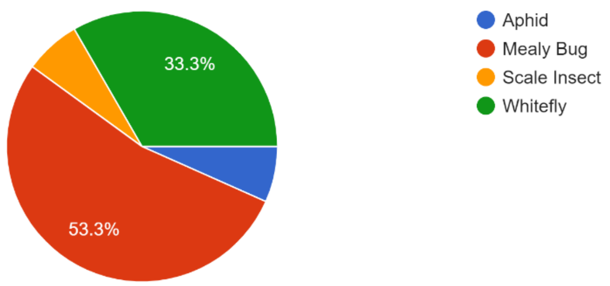


Figure 17: Survey response 8

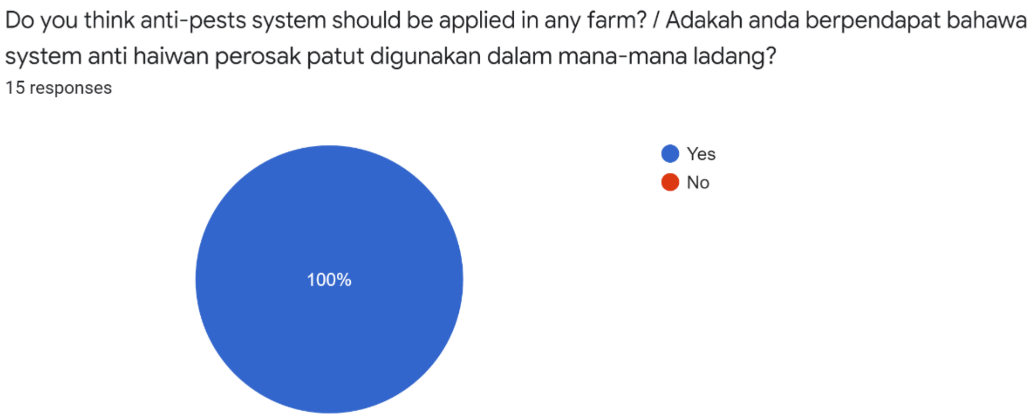


Figure 18: Survey response 9

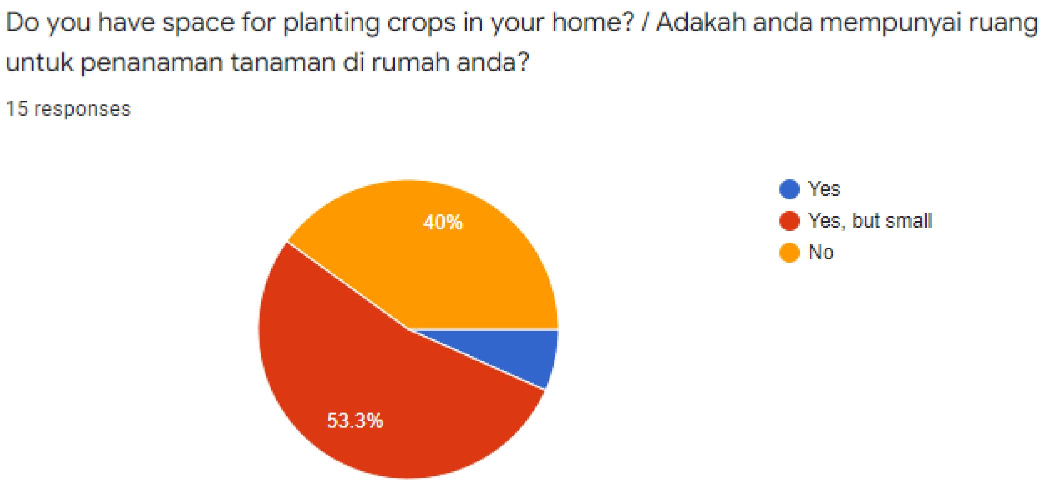


Figure 19: Survey response 10

Table 3: Detailed Customer Need Statement.

No	Need		Important
1	The smart farming system can	Ensure plant grow well	5
2	The smart farming will not	Cause harm to their crops	5
3	The smart farming system can	Automatically water the plant based on the moisture sensor	5
4	The smart farming system can	Ensure plants get enough water	5
5	The smart farming system can	Reduce excessive water wastage due to watering plant	5

6	The smart farming system can	Ensure plants get all required nutrient	4
7	The smart farming system can	notify the owner if it is raining	3
8	The smart farming system can	Prevent pests from causing harm to their crops	5
9	The smart farming system can	help plant grow in challenging weather, pests disturb and bacteria disease	4
10	The smart farming can	Be used in urban areas and limited amount of space	4
11	The smart farming can	Be install at affordable price	4
12	The smart farming can	Be used for a very long time	5

6.1.4 List of Metric

Table 4: List of Metric with Units

No	NEED No	Metric	Unit
1	1,2,3,4,5	Volume of water through the pipe per day	m^3
2	1,2,3,4,5	Duration of water supply	h
3	2,3,4,5	Size of water container	m^3
4	1,2,6	Volume of nutrient applied in a week	m^3
5	1,2,6	Total of mass flow rate of nutrient per week	kg/s

6	1,2	Average Temperature of the environment	◦c
7	1,3,4,5,7	Soil Moisture	g/kg^-1
8	12	Weight of the platform	Kg
9	3,4,5	Length of the pipe	m
10	3,4,5	Diameter of the pipe	m
11	1,2,4,5,6,12	Pump horsepower	kW
12	11,12	Power Efficiency	
13	11,12	Energy Usage Per hour	J/hour
14	11	Installation cost	RM
15	2,12	Product Durability	Day
16	8,9	Obstacle Detection through infrared sensor	m
17	10	Size of the module	m^3

6.1.5 Need-Metric Chart

Table 5: Metric-Need Chart Table

	METRIC	**Volume of water through the pipe per day**	**Duration of water supply**	**Size of water container**	**Volume of nutrient applied in a week**	**Total of mass flow rate of nutrient per week**	**Average Temperature of the environment**	**Soil Moisture**	**Weight of the platform**	**Length of the pipe**	**Diameter of the pipe**	**Pump Horsepower**	**Power Efficiency**	**Energy usage per hour**	**Installation cost**	**Product Durability**	**Obstacle detection by infrared sensor**	**Size of the module**
NO	NEED	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Ensure plant grow well	/	/		/	/	/	/				/						
2	Not Cause harm to their plant	/	/	/	/	/	/					/				/		
3	Automatically water the plant based on the moisture sensor	/	/	/				/		/	/							
4	Ensure plant get enough water	/	/	/				/		/	/	/						
5	Reduce excessive water wastage due to watering the plant	/	/	/				/		/	/	/						
6	Ensure plant get all required nutrient				/	/						/						
7	Notify the owner if it is raining							/										

8	Prevent pests from causing harm to their crops																/	
9	Help plant grow in challenging weather, pests disturb a nd bacteria diseas e																/	
10	Can be used in urban areas and limited amount of space																	/
11	Be install at affordable price											/	/	/				
12	Be used for a very long time								/			/	/	/		/		

6.1.6 Problem Decomposition

Nutrient and water supply

Existing: Yes, there are a lot of modern farmers apply the automated system such as automated watering system, but it is not based on the real-time status of the plants. Mostly the automated system today based on time where the system will supply the things needed by the crop according to the fixed time.

New: In our product, it is equipped with soil moisture detection to control the water supply to the plant. If the soil moisture fall below 30%, the relay will automatically switch on the pump to pull up the water to the module.

Monitoring system

Existing: Traditionally, farmers struggle to monitor the amount of water, nutrients and pH of the soil from observation only. Plus, this is very crucial for the plants as these 3 main elements that contribute most in developing a healthy plant.

New: We manage to plan a more practical and relevant monitoring system to handle with these elements which is using various of sensors (rain sensor, fertilizer level sensor, temperature sensor and soil moisture sensor) to collect data and show us the percentage of the water, nutrient, and temperature in the soil. This will give us the chance to determine the amount to add or remove from the growth medium. In addition, this system also will update the real time data of soil moisture, temperature, and nutrient level through Blynk application in our smartphone.

Portability

Existing: Current smart farming also only focused on the farmer but not the average consumer. There are very little start up focusing on smart farming for home owner especially for high rise resident. Then, the traditional design of smart farming is not portable and need to be fixed at certain location.

New: The design of the system is in a module form, so it is portable to another place and suitable for high rise resident.

6.2 Concept Generation

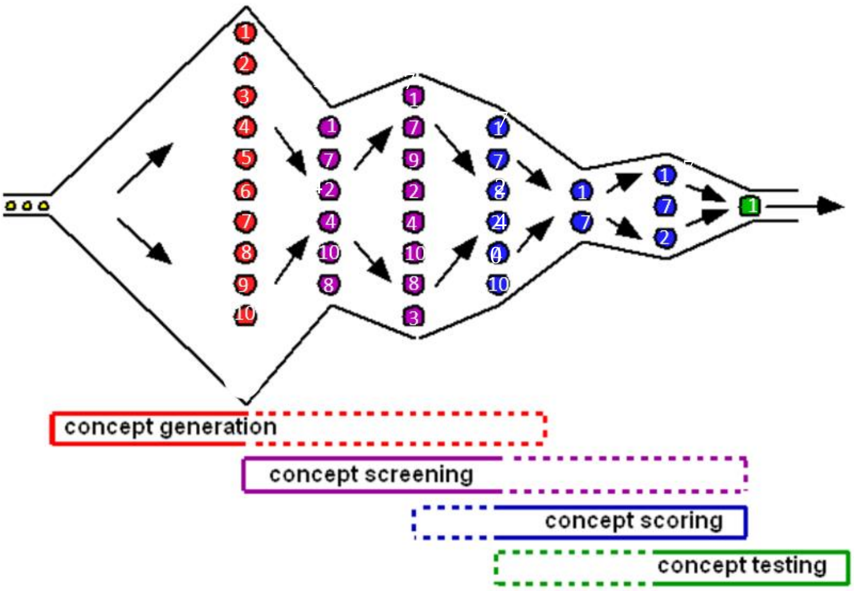


Figure 20:Concept selection flow chart

Table 6: Concept Generation Table

Concept	Criteria	Type of controller	Type of sensor	Optimised Output
1	Soil moisture, nutrient level, water level, rain sensor, temperature detection, buzzer alarming, and	Noda Lua MCU	Humidity sensor, Rain sensor, water level sensor, infrared sensor	Automatic Watering, Automatic nutrient supply Buzzer Alarming, Water level optimisation

	portable module			Real time monitoring through smartphone Switch control in application
2	Humidity, solar detection, soil nutrient	Bluetooth	Light sensor, Humidity sensor, temperature sensor	Automatic Watering, Buzzer Alarming
3	Solar detection, soil pH, soil moisture	Human	Light sensor, pH sensor, turbidity sensor	Automatic Watering, Temperature Optimisation
4	Solar detection, soil nutrient, pH sensor	Automatic light sensor controller	Soil moisture sensor, pH sensor, Temperature sensor	Automatic Watering, pH Neutralisation
5	Soil pH, Soil moisture	Micrologix	Humidity sensor, pH sensor, light sensor	Automatic Watering, pH Neutralisation

6	Soil moisture, soil pH, solar detection, soil nutrient	Micrologix	Soil moisture sensor, pH sensor, Temperature sensor	Automatic Watering, pH Neutralisation, Buzzer Alarming, Temperature Optimisation
7	Solar detection, soil pH, soil moisture	Bluetooth	Humidity sensor, pH sensor, light sensor	Automatic Watering, pH Neutralisation
8	Soil moisture, soil pH, solar detection, soil nutrient	Arduino UNO	Soil moisture sensor, pH sensor, Temperature sensor	Automatic Watering, pH Neutralisation, Buzzer Alarming, Temperature Optimisation
9	Solar detection, soil nutrient, pH sensor	Automatic light sensor controller	Light sensor, pH sensor, turbidity sensor	pH Neutralisation, Temperature Optimisation

10	Soil pH, Soil moisture	Arduino UNO	Soil moisture sensor, pH sensor, Temperature sensor	Automatic Watering, pH Neutralisation, Buzzer Alarming, Temperature Optimisation

6.3 Concept Selection

6.3.1 Decision Metric Table

Table 7:Decision Metric Table

	No	1	2	3	4	5	6	7	8	9			
	Selection of Criteria	Ease of Use	Availability of Component in the market	Ease of Connection	Security of the product	Automation Function ability	Nutrient detection accuracy	Cost	Durability	Ease of Manufacture	Total Score	Rank	Continue?
Concept	Weight	0.1	0.1	0.1	0.1	0.15	0.1	0.15	0.1	0.1			
1	Rating	5	5	5	4	5	3	4	3	4			
	Weight Score	0.5	0.5	0.5	0.4	0.75	0.3	0.6	0.3	0.4	4.25	1	/
2	Rating	4	4	5	4	3	4	2	3	4			
	Weight Score	0.4	0.4	0.5	0.4	0.45	0.4	0.6	0.3	0.4	3.85	3	X
3	Rating	2	5	5	3	2	2	5	3	4			
	Weight Score	0.2	0.5	0.5	0.3	0.3	0.2	0.75	0.3	0.4	3.45	7	X
4	Rating	3	5	3	3	3	3	5	3	4	3.60	4	X

	Weight Score	0.3	0.5	0.3	0.3	0.45	0.3	0.75	0.3	0.4			
5	Rating	2	2	3	4	4	4	2	3	3	3	10	X
	Weight Score	0.2	0.2	0.3	0.4	0.6	0.4	0.3	0.3	0.3			
6	Rating	2	3	3	4	4	4	2	3	3	3.1	9	X
	Weight Score	0.2	0.3	0.3	0.4	0.6	0.4	0.3	0.3	0.3			
7	Rating	4	5	4	5	4	3	4	4	4	3.9	2	X
	Weight Score	0.4	0.5	0.4	0.5	0.6	0.3	0.4	0.4	0.4			
8	Rating	3	5	3	4	4	4	3	4	3	3.5	6	X
	Weight Score	0.3	0.5	0.3	0.4	0.6	0.4	0.3	0.4	0.3			
9	Rating	5	3	4	3	5	5	1	2	3	3.4	8	X
	Weight Score	0.5	0.3	0.4	0.3	0.75	0.5	0.15	0.2	0.3			
10	Rating	5	4	3	3	2	3	4	2	5	3.5	5	X
	Weight Score	0.5	0.4	0.3	0.3	0.3	0.3	0.6	0.3	0.5			

6.4 Detail Project Design

6.4.1 Solidwork Design

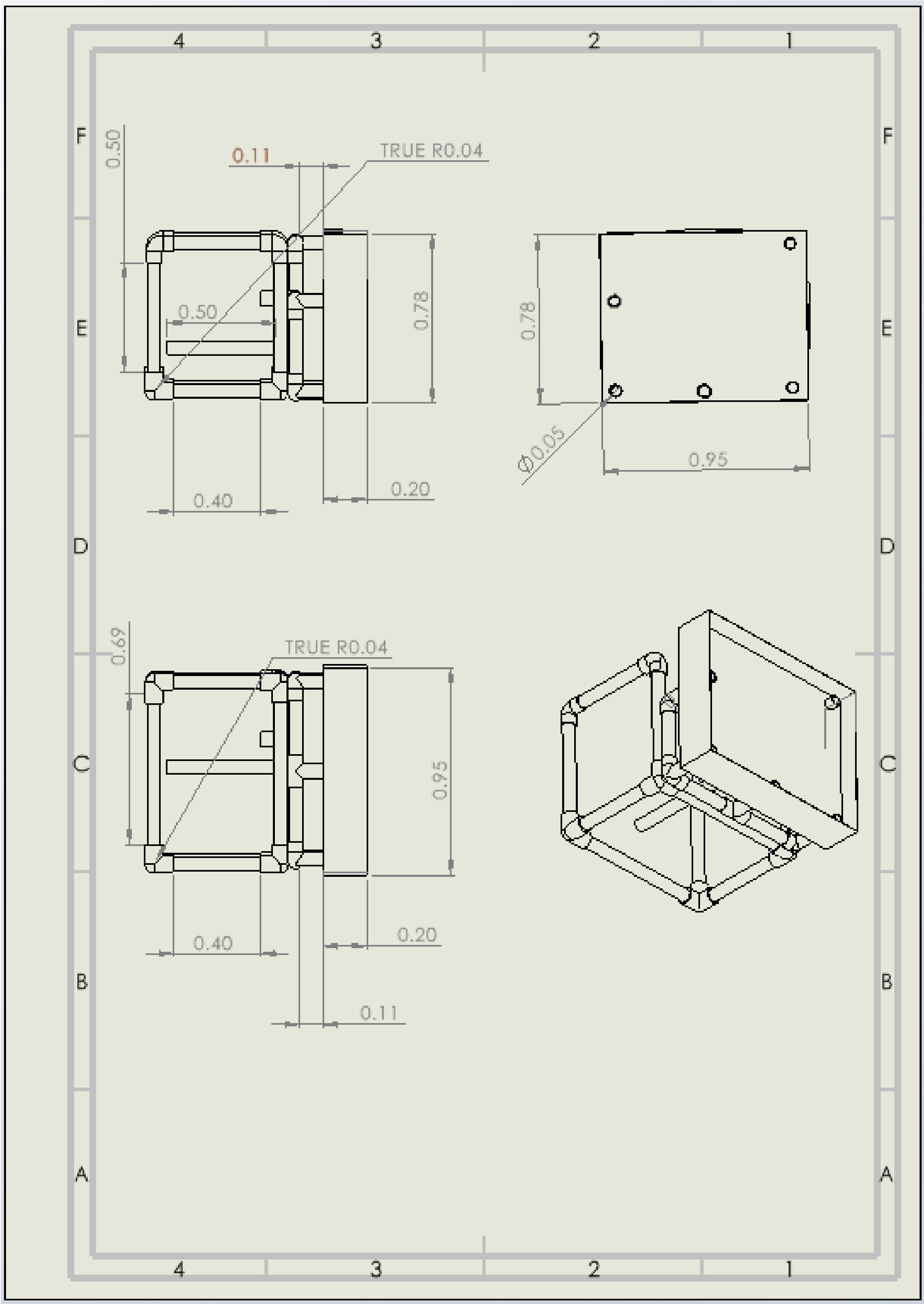


Figure 21:Orthographic projection of the system

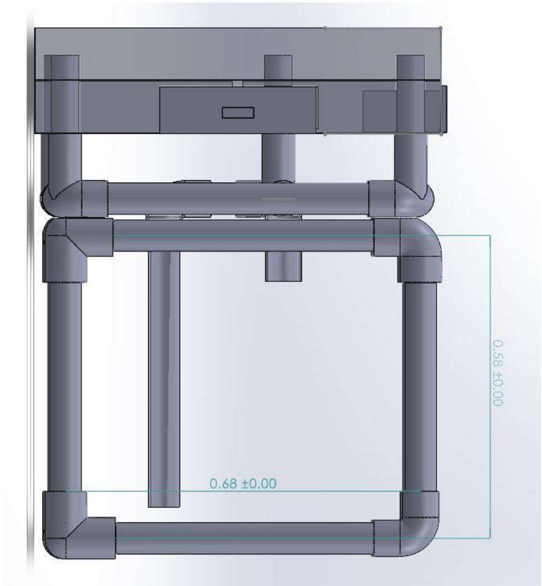


Figure 22: Right view of the system

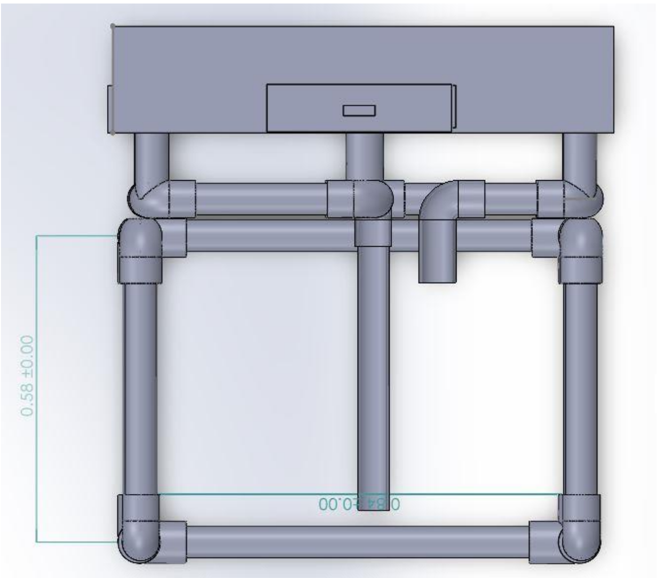


Figure 23: Front view of the system

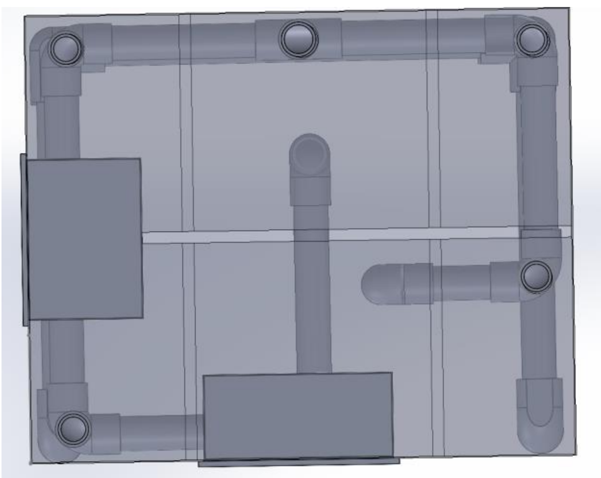


Figure 24: Top view of the system

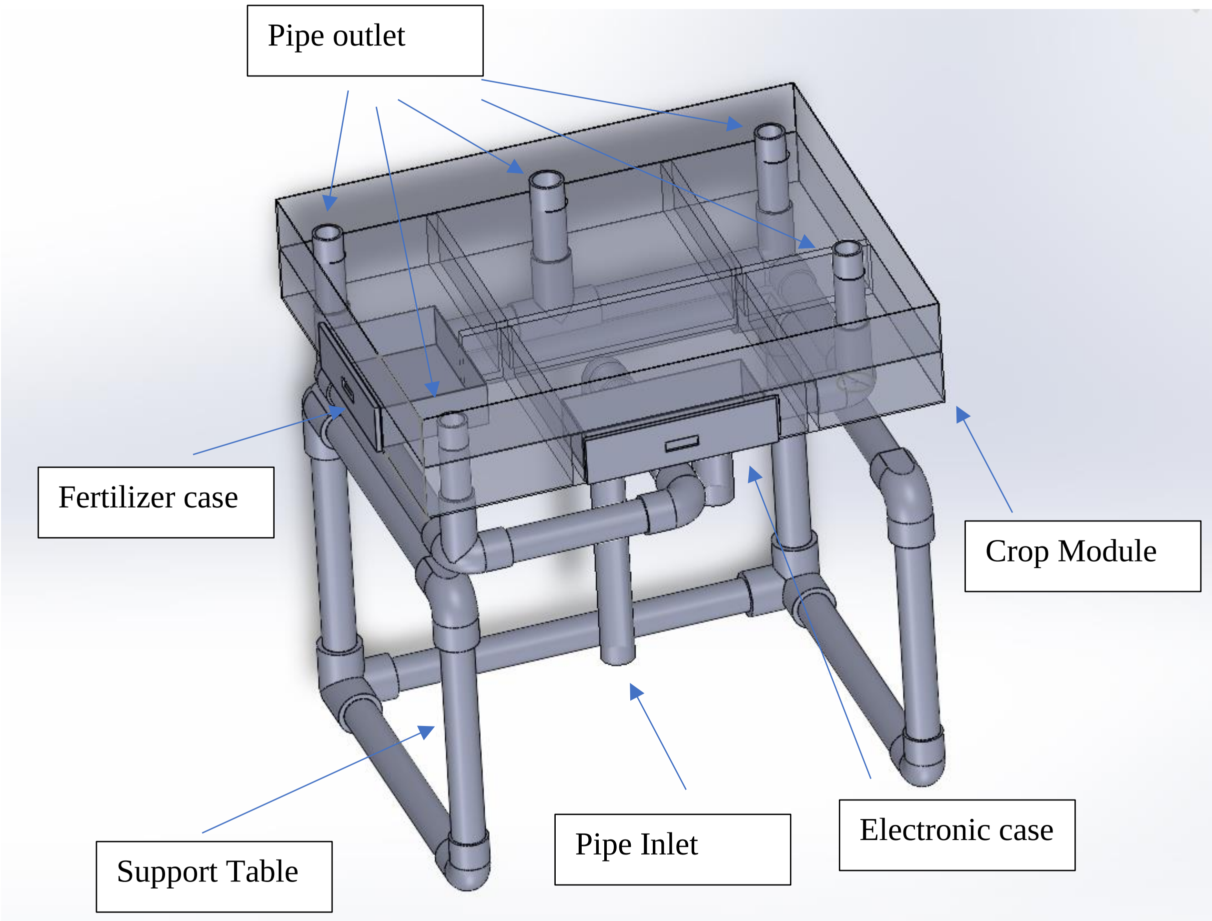


Figure 25: Isometric view of the system

Detail drawing of Crop module

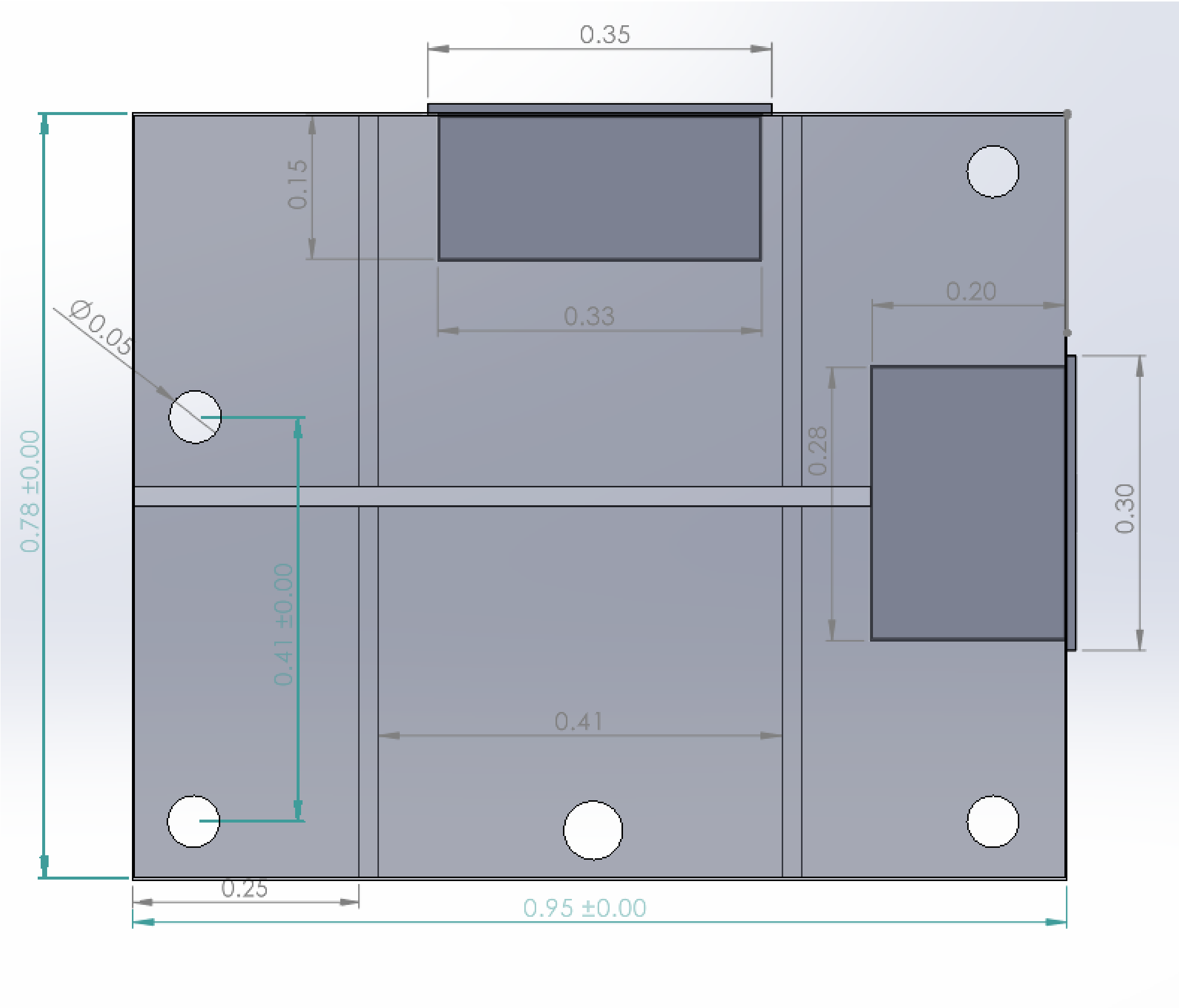


Figure 26:Top View of the support table

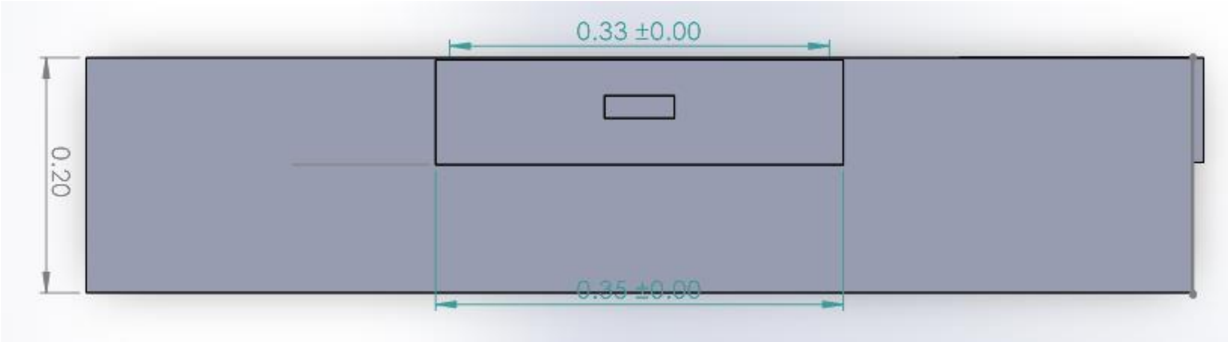


Figure 27:Front View of the support table

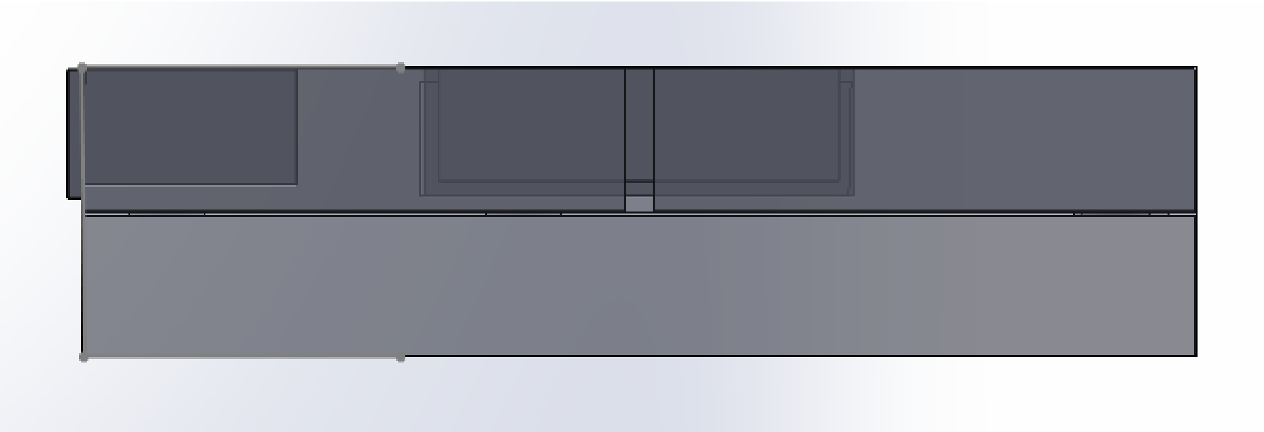


Figure 28:Right view of the support table

Detail drawing of Pipe Channel

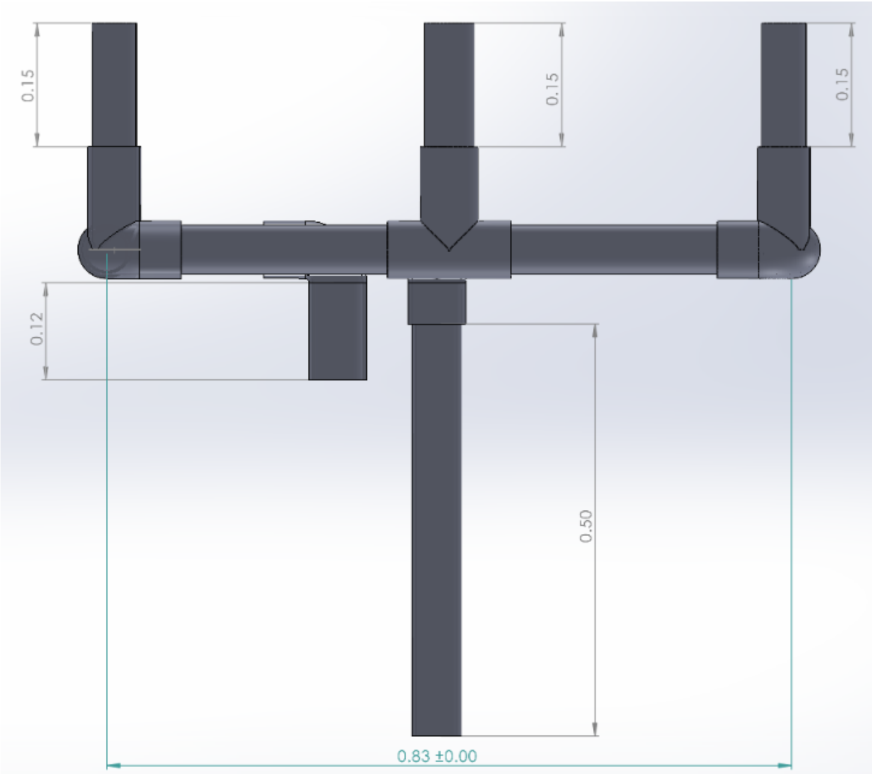


Figure 29:Front view of the piping channel

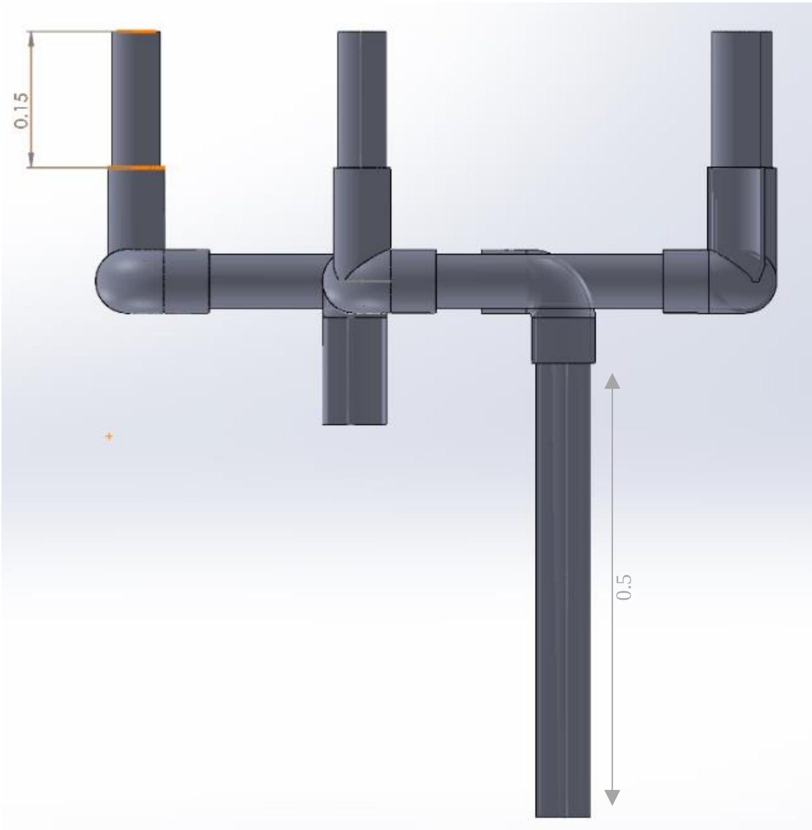


Figure 30:Right view of the pipe channel

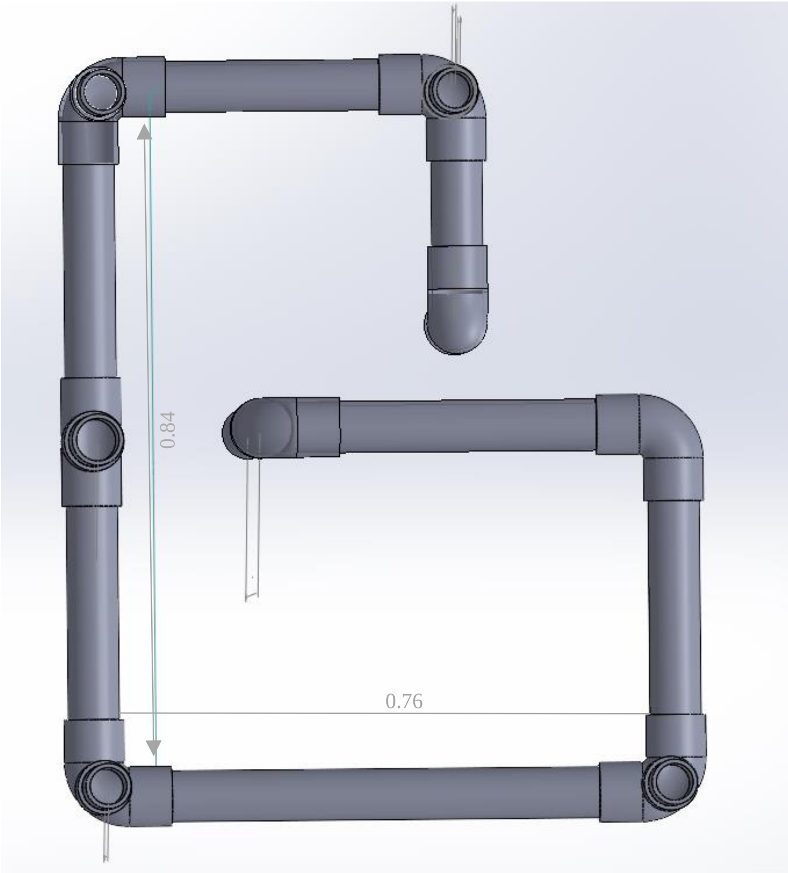


Figure 31:Top View of the pipe channel

Detail drawing of support table

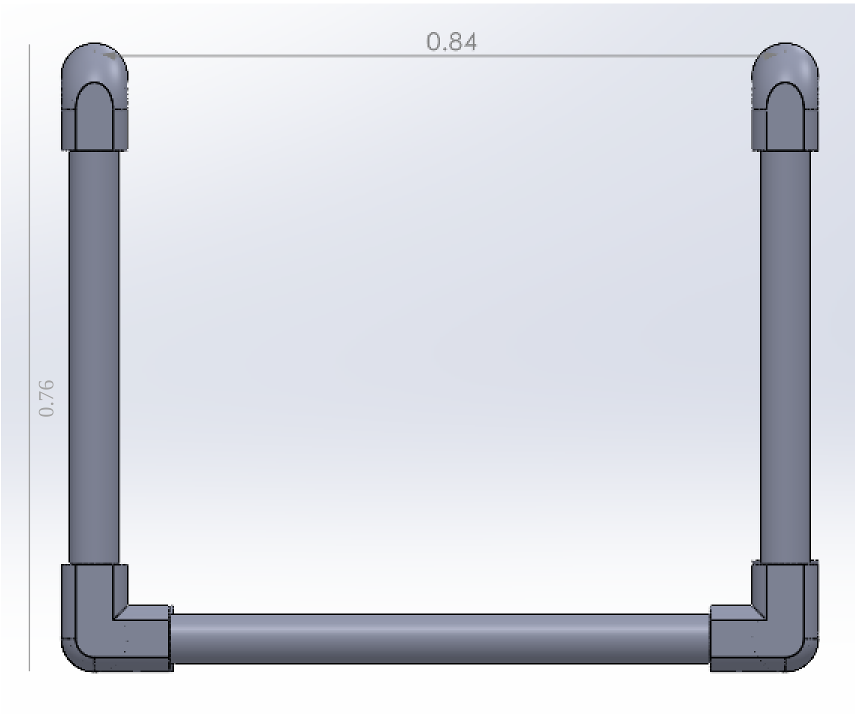


Figure 32:Top View of the support table

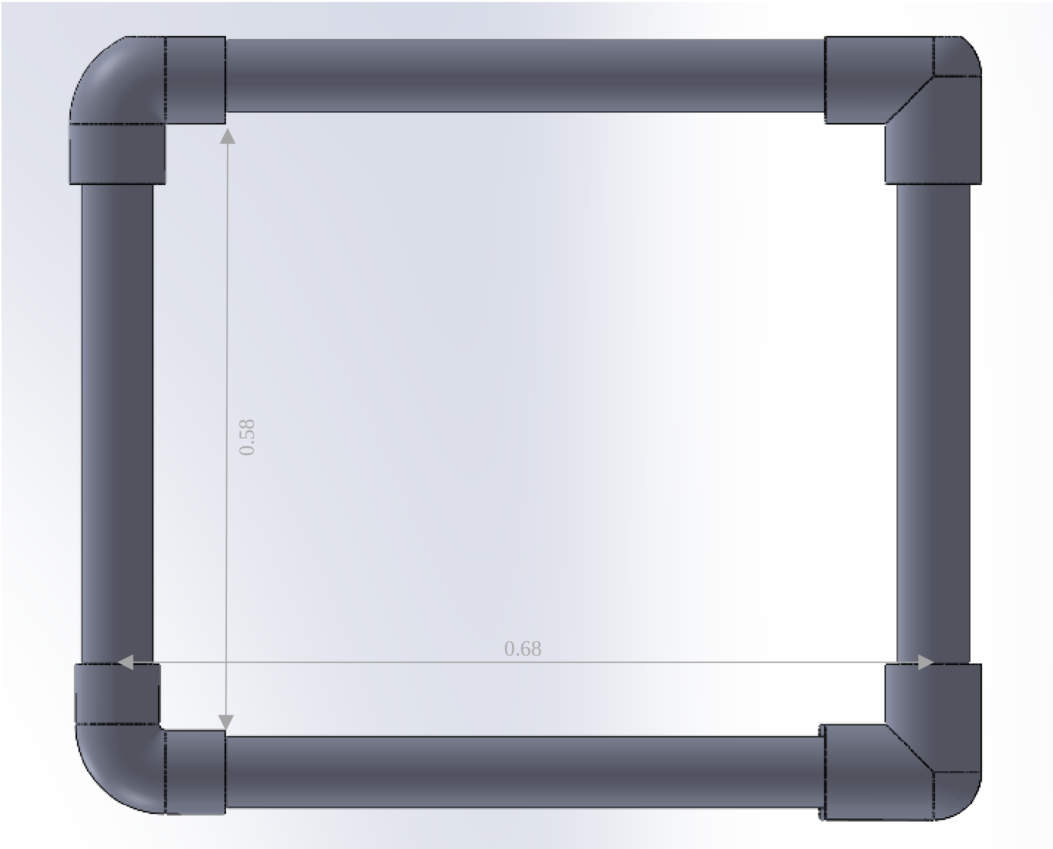


Figure 33:Right view of the support table

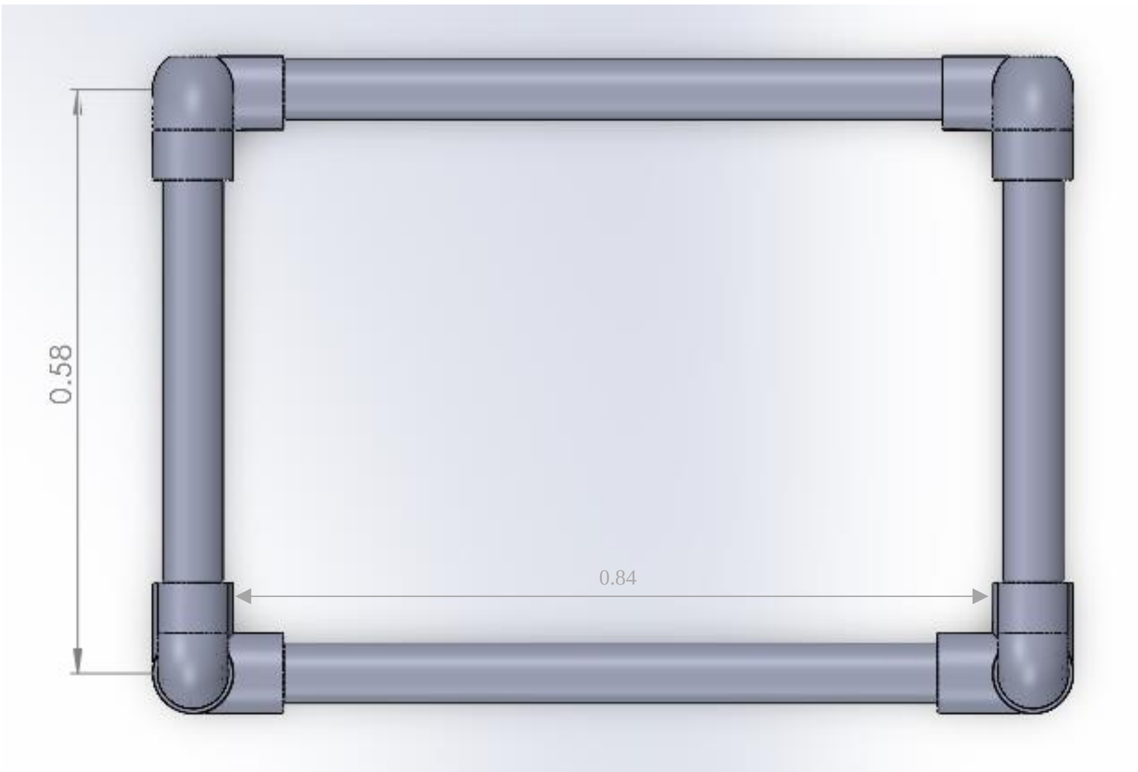


Figure 34:Front view of the support table

Figure 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, and figure 25 shown the design drawing of the whole carefree smart farming system. The measurement used is in unit of meter.

6.4.2 Product Specification

Table 8:Material Specification

No	Part	Material	Reason of Selection
1.	Case of the module	Acrylic Plastic	• Excellent optical clarity and transparency • 17 times stronger than glass in term of impact resistance. • Can be cut using band saw machine and bench drill machine.
2.	Pipe	PVC	• Strong material • Easy to cut • Cheaper than metal
3.	Adhesive	Silicon Glue	• Strong and tight adhesive • Act as a waterproof sealant and water repelling. • Good Thermal stability • Low chemical Reactive with soil and nutrient
4.	Support Table	PVC	• Stronger than MDF board • Easy to cut • Cheaper than metal

6.4.3 Electronic Component

Table 9:Electronic Component Specifications

No	Component	Reason of Selection
1.	NodeMCU Lua V3 ESP8266 WIFI with CH340C	• Low Cost Wifi Chipset integrated Microcontroller • Integrated ESP8266 chipset with CH340C microprocessor • Arduino-like hardware Input/Output
2.	Moisture Sensor Module	• Low cost • Analog and digital output available • Optionable 3.3V or 5V voltage supply
3.	Rain Sensor Module	• Low cost • Optionable 3.3V or 5V voltage supply
4.	Infrared Sensor Module	• Optionable 3.3V or 5V voltage supply • Obstacle detection range: 2cm to 10cm • Adjustable sensitivity(range) with on board potentiometer • Small size

5.	Waterproof temperature sensor	• Optionable 3.3V or 5V voltage supply • Waterproof sealed with stainless steel • -55°C to+125°C temperature range • ±0.5°C accuracy from -10°C to +85°C
6.	Resistor 1k Ohm	• adjust signal levels before transmitting into MCU
7.	Single Channel 5V Relay Breakout Board	• Controllable Digital output • Compatible with any 5V microcontroller • High switching current up to 10A • High maximum allowable power force up to 800V AC/ 240W
8.	Buzzer-PCB Mount	• High operating voltage of 2-6V DC
9.	Jumper wire (Male to Male)	• Perfect for connecting circuits and doing prototypes on breadboard and Arduino
10.	Jumper wire (Male to Female)	• Perfect for connecting circuits and doing prototypes on breadboard and Arduino
11.	Jumper wire (Female to Female)	• Perfect for connecting circuits and doing prototypes on breadboard and Arduino
12.	Breadboard 8.5x5.5cm (400 Holes)	• Solderless • Modify circuit easily, suitable for prototype building
13.	Crocodile Clip with wires (10pcs)	• Strong and grippy without soldering
14.	Power Adapter 12V 1A (UK Plug)	• Convert the main electricity (100V-240V AC) to 12 volts (DC)
15.	DC Jack (Female) to Screw Terminal Adapter	• convert to screw terminal if you need to connect a DC power wall wart to a board that doesn't have a DC jack, eg I/O pin
16.	R385 DC12V Diaphragm Water Pump	• Low Rated current: 0.5A • Low Power Rating: 6W • Flow Rate: 1.6L ± 0.1L / min • Water pressure at inlet: 0.3Mpa (MegaPascal), or 43.51 psi • High Max continuous operating hour: 12 hours

6.5 Detailed Analysis

6.5.1 Static Load Test

It is very crucial to test the ability of our design to ensure the safety of our customer. To achieve this, Solidwork Simulation Model is used to test the maximum load it can withstand. As were mentioned in the specification part, the material of the table is PVC pipe. The material of the table part is defined as PVC. Then, we need to set the fixed geometry parts which are at any surface that have contact with the ground. From Figure 27, the fixed geometry parts are shown in green colour. Next step, we need to set where the load will exert on the table which are shown as pink colour in Figure 27, For this test, the load of the upper module exerted 50N on the support table. Then the final step before running the test, we need to generate mesh for the model. The parameter used is blended curvature-based mesh. Then, for the Jacobian points are set at the node.

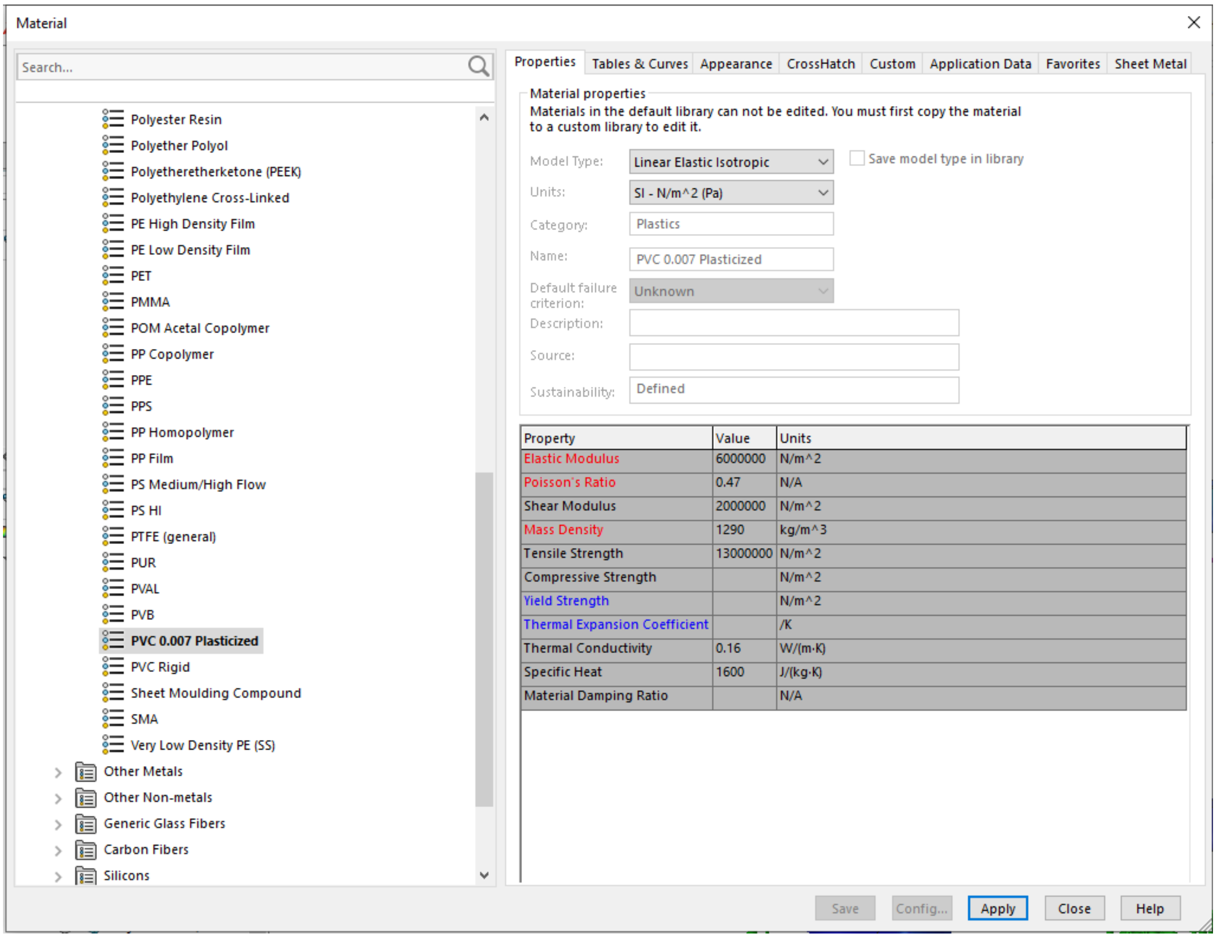


Figure 35:Material selection for static load test in Solidwork

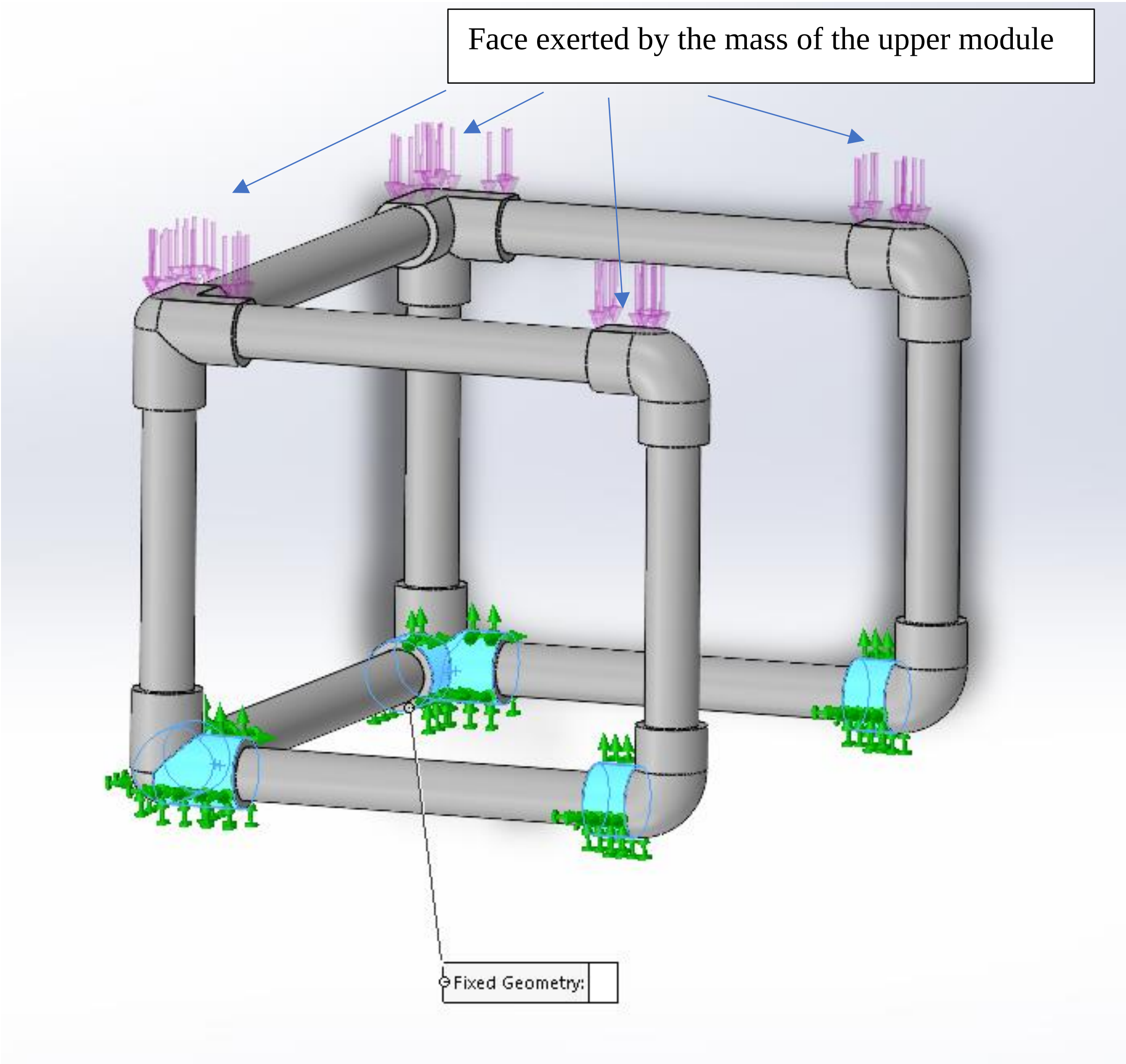


Figure 36:Setting up fixed geometry in static load test

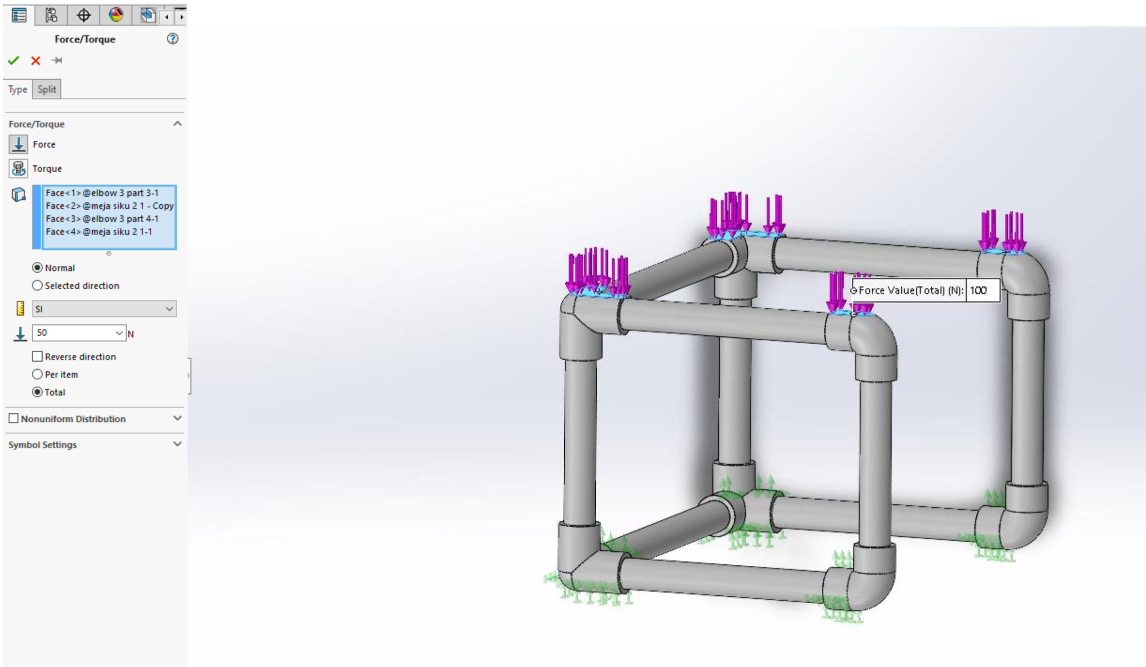


Figure 37:Setting up the external force on the support table

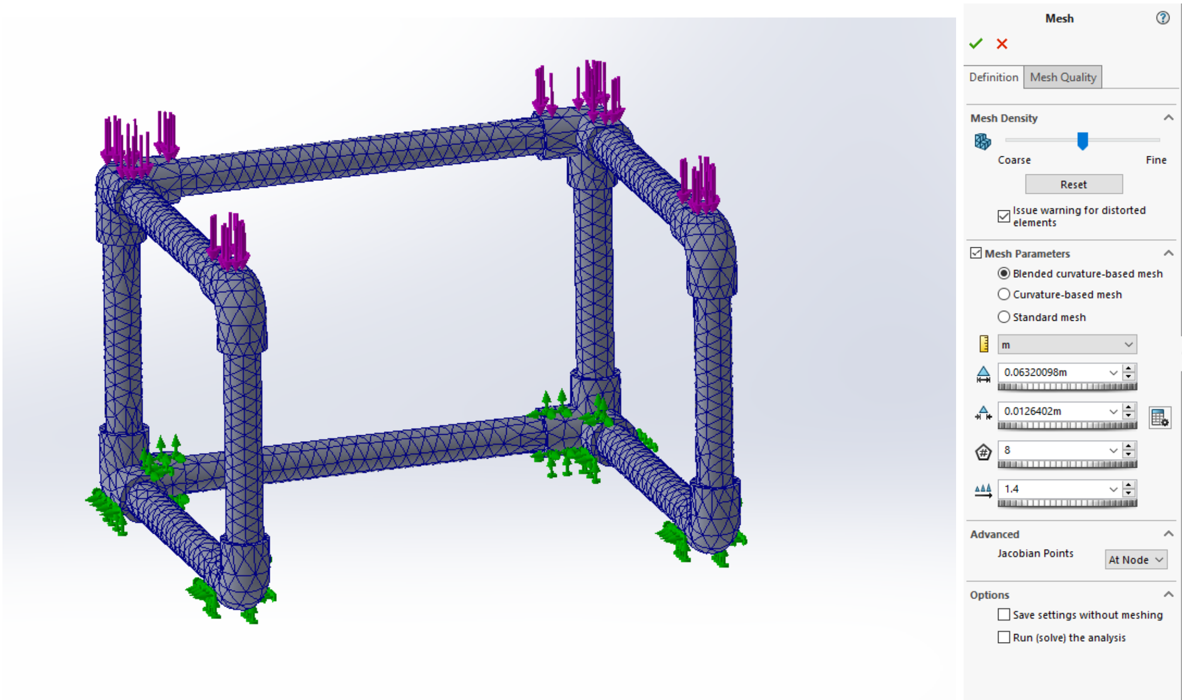


Figure 38: Generate mesh for the support table model.

Figures 30, 31 and 32 shown Von Misses Stress, deflection, and strain across the support table. The support table model is shown with different colour gradient indicator. This simulation was done by using Solidworks simulation feature. From this test, the support table is exerted by 50N of force represented by the load of the upper module at four different points. From figure 30, Von Misses Stress shown in green colour at the left and right pillar of the support table.

While at the other part the colour remains in blue colour. These indicator means, the support are experiencing mild stress at the pillar due to the external force which is the load from the case module. The highest value of the Von Misses stress is 5.216×10^4Pa. However, this stress is still in an acceptable range and can be proven by calculating the factor of safety.

$$Factor\ of\ Safety = \frac{Ultimate\ Stress}{Actual\ Stress} - Equation\ 1$$

Ultimate strength of PVC pipe = $52 \times 10^6 Pa$

Highest value of the Von Misses stress experienced by the support table is 5.216×10^4Pa

$$Factor\ of\ Safety = \frac{52 \times 10^6 Pa}{5.216 \times 10^4 \text{Pa}}$$

$$Factor\ of\ Safety = 996.933$$

Hence, this structure is impossible to fail since having a large value of factor of safety.

Then, figure 31 shown the deflection across the support table. From this figure, the larger deflection occurs at the centre of the support at the indicated by red colour. Then, at the side of the support table are shown in green colour which mean mild deflection. However, the model only deflects 0.6mm at the middle of the support table which is still in an acceptable range. The comparison of the deflection between two situation can be seen in figure 33 and figure 34.

Lastly, figure 32 shown the strain experienced by the support table model. From this figure, the largest strain occurs at the support pillar of the table at value of $6.283 \times 10^{-3} m/m$.

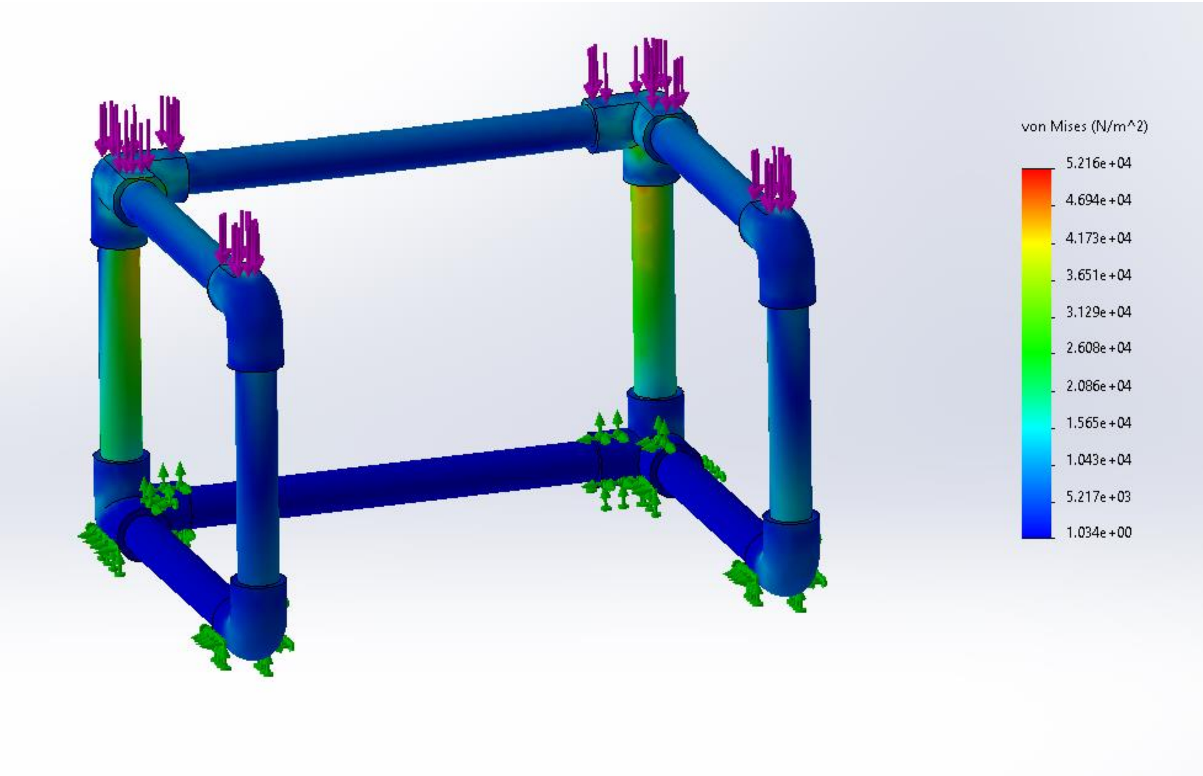


Figure 39:Von Misses Stress across the support table

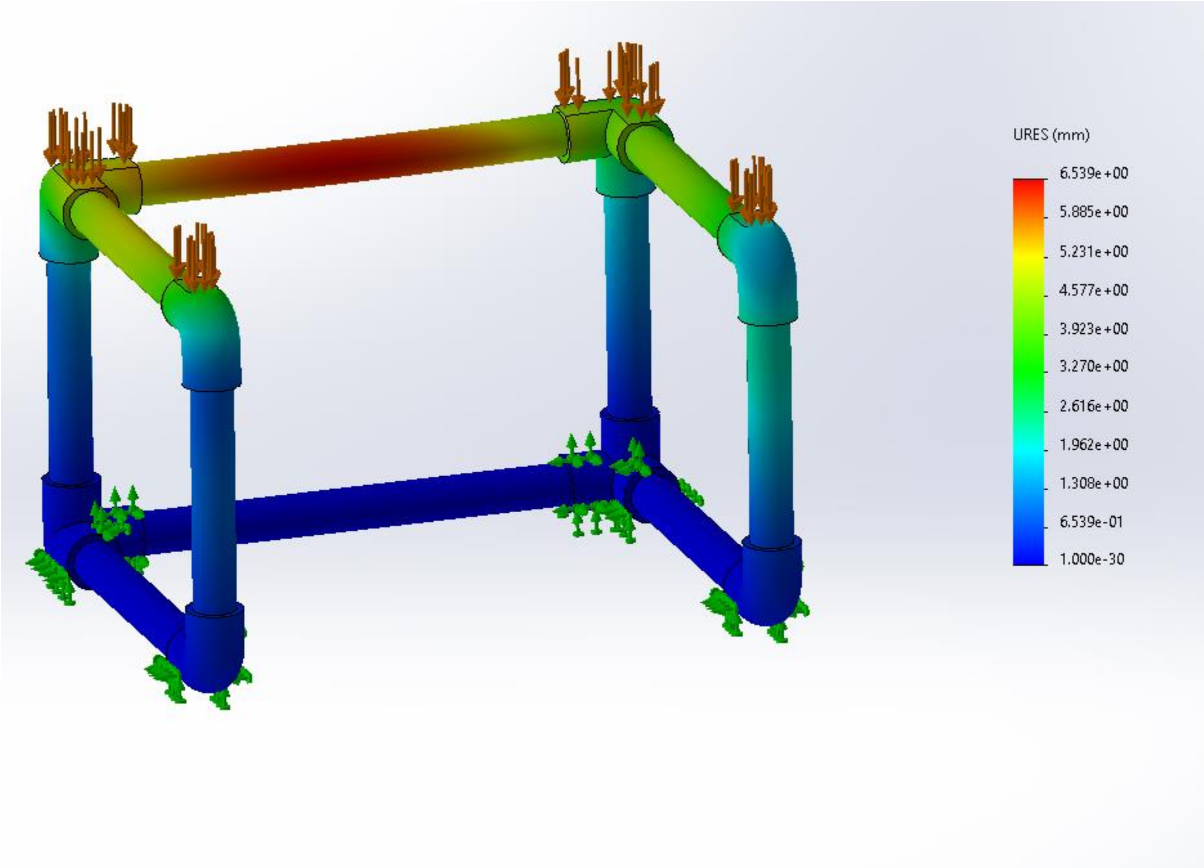


Figure 40:Deflection across the support table

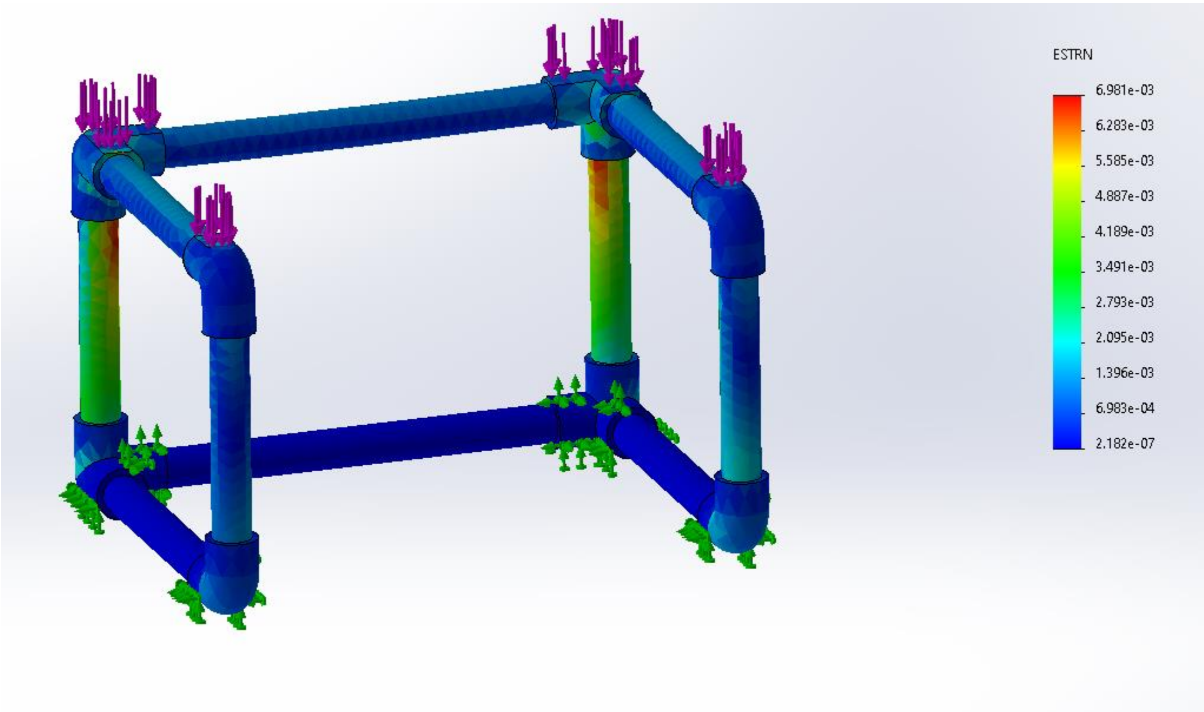


Figure 41:Strain across the support table

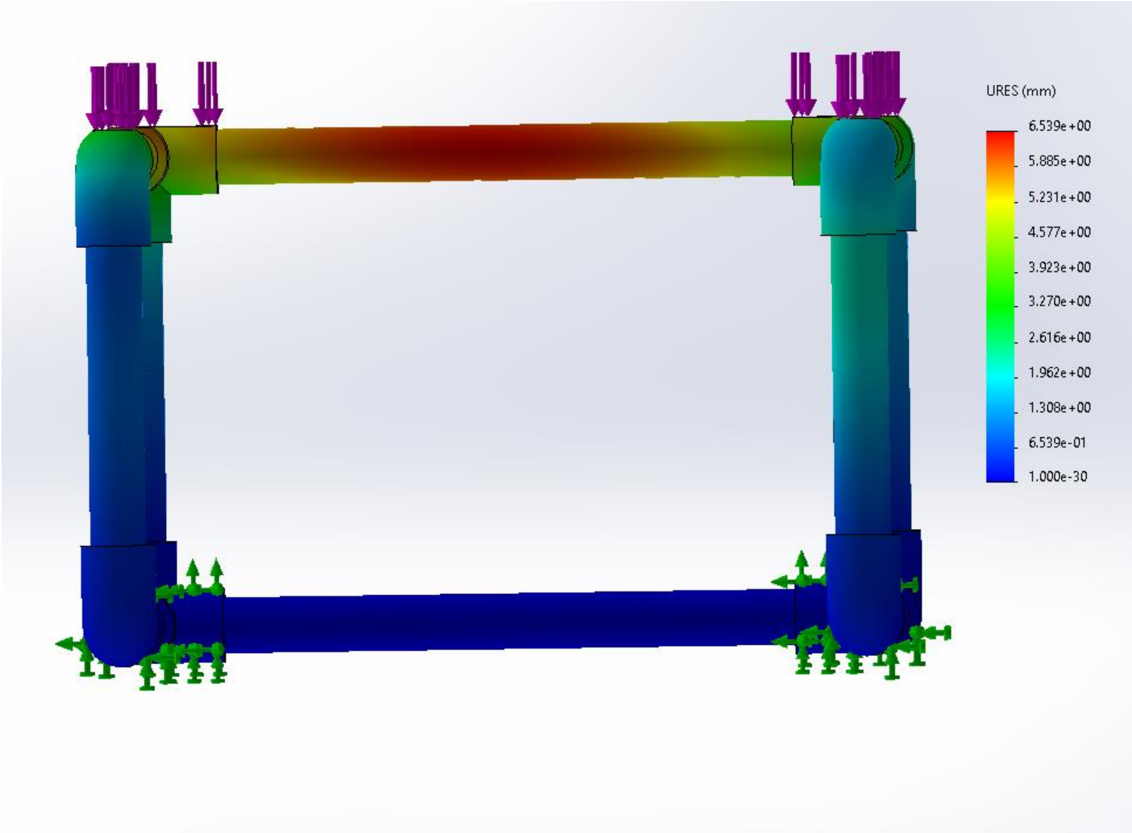


Figure 42:Undeformed result

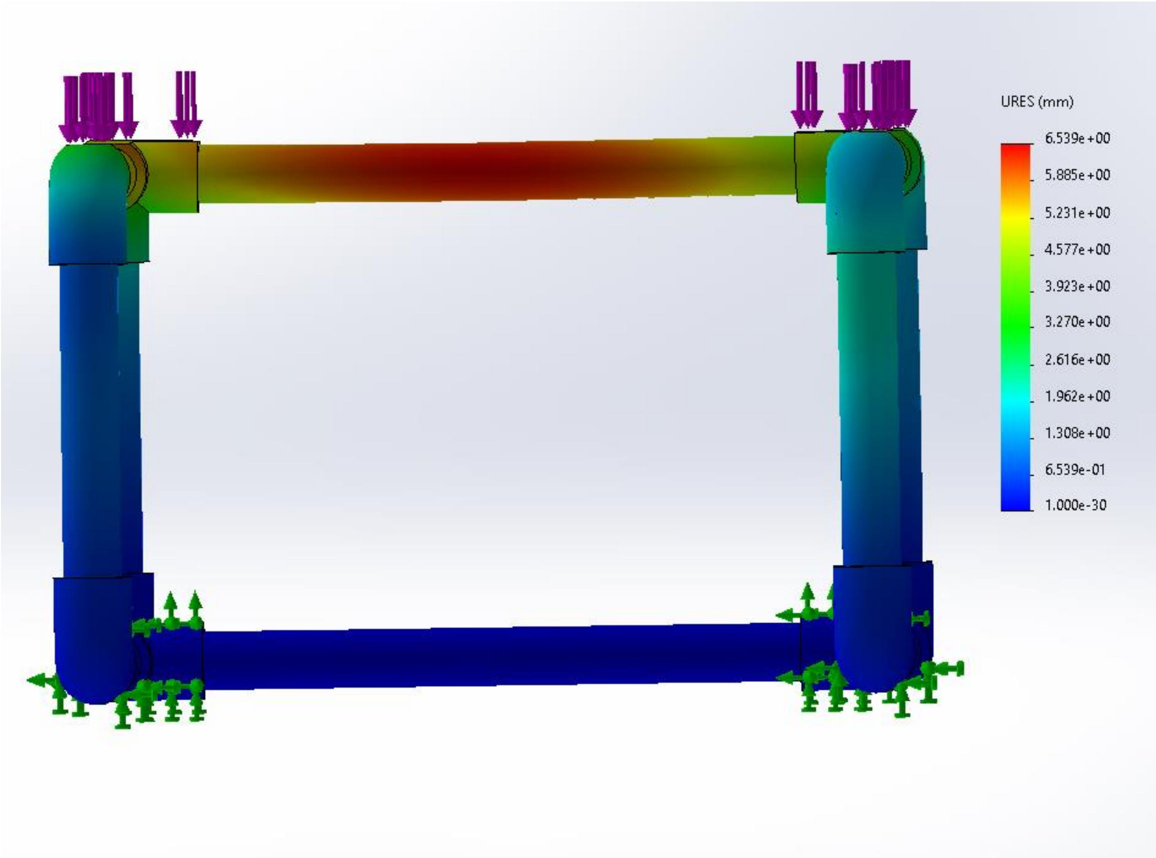


Figure 43: Deformed Result

6.5.2 Fluid Mechanic Test

Calculation of Pump Power Required for the system

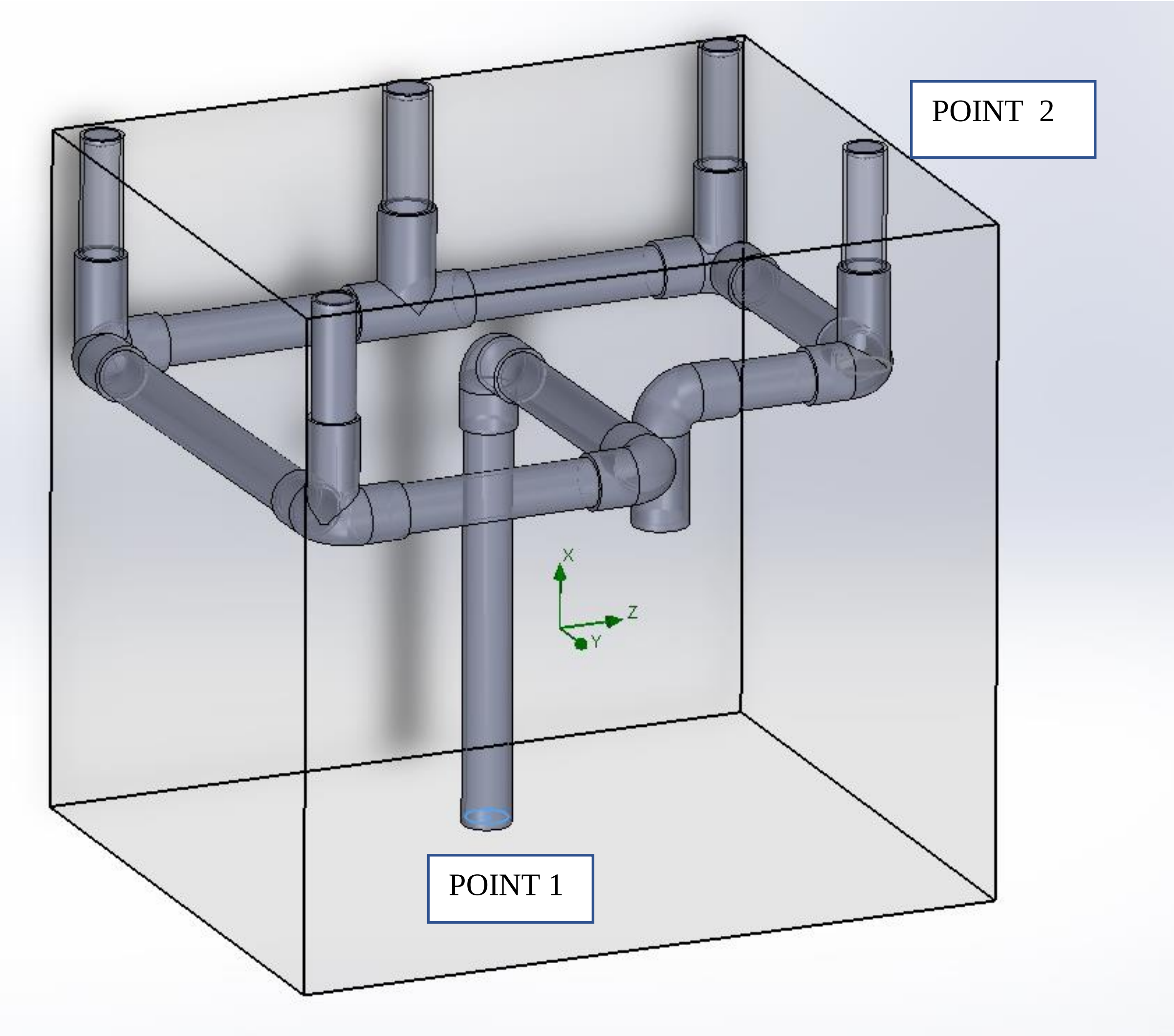


Figure 44:Position of point 1 and point 2 for pump calculation analysis.

$$\frac{P_1}{\rho g} + \alpha_1 \frac{{V_1}^2}{2g} + z_1 + h_{pump,u} = \frac{P_2}{\rho g} + \alpha_2 \frac{{V_2}^2}{2g} + z_2 + h_{turbine,e} + h_L - Equation\ 2$$

Pressure at point 1 and 2 are 1 atm and same with each other

$P_1 = P_2 = P_{atm}$ >> $P_1 - P_2 = 0$ $- Equation\ 3$

$V_1$and V_2 $were\ steady$

V_1=V_2 >>V_1 −$V_2 = 0$ $-Equation\ 4$

Since there is no turbine in the system

$h_{turbine,e} = 0$

$$h_{pump,u} = (z_2 - z_1) + h_L - Equation\ 5$$

$z_2 - z_1 = 0.43m$

$$h_L = (f\frac{L}{D} + \sum K_L)\frac{V^2}{2g}$$

Volume flow rate 1.8m^3/h=

Diameter of pipe 5cm

Velocity = V/A

$$V = \frac{1.8}{60 \times 60 \times \pi \times (0.025)^2}$$

V=0.25465m/s

Then find Reynold's Number at each volume flow rate.

Dynamic viscosity of water at room temperature

$$\mu = 0.00085Pa$$

$$Re = \frac{\rho V D}{\mu}$$

$$Re = \frac{1000 \times 0.25465 \times 0.05}{0.00085}$$

$$Re = 14979.41176$$

Hence the flow is in turbulent flow

Table 10:Loss Coefficient Value for the system

Bends and Valves	Quantity	Loss coefficient, K_L	Total lost coefficient, K_L
Main Pipe exit	5	1.05	5.25
90 degrees threaded elbow	6	0.9	5.4
Pipe inlet	1	0.5	0.5
TOTAL K_L			11.15

Then find the friction factor for each flow rate

$$\frac{1}{\sqrt{f}} = -1.8\log\left[\frac{6.9}{Re} + \left(\frac{(\frac{\varepsilon}{D})}{3.7}\right)^{1.11}\right]$$

Friction factor for $1.8\frac{m^3}{h}$ flow rate

$$\frac{1}{\sqrt{f}} = -1.8\log\left[\frac{6.9}{Re} + \left(\frac{\left(\frac{\varepsilon}{D}\right)}{3.7}\right)^{1.11}\right] - Equation\ 6$$

$Surface\ roughness\ for\ plastic\ pipe, \varepsilon = 0$

$$\frac{1}{\sqrt{f}} = -1.8\log\left[\frac{6.9}{Re}\right]$$

Friction factore for $1.8\frac{m^3}{h}$ flow rate, $Re = 14979.41176$

$$\frac{1}{\sqrt{f}} = -1.8\log\left[\frac{6.9}{14979.41176}\right]$$

$$\frac{1}{\sqrt{f}} = 6.00596$$

$$f = \left(\frac{1}{6.00596}\right)^2$$

$$f = 0.027723$$

Find the minor losses H, minor

Total length = 3.24m

$$h_L = (f\frac{L}{D} + \sum K_L)\frac{V^2}{2g} - Equation\ 7$$

$$h_L = \left(0.027723\frac{3.24}{0.05} + 11.15\right)\frac{0.25465^2}{2(9.81)}$$

h_L =0.0428m

H, useful pump =H loss + H, height different

$$h_{useful\ pump} = h_{height\ different} + h_{loss} - Equation\ 8$$

$$h_{useful\ pump} = 0.87 + 0.0428$$

$$h_{useful\ pump} = 0.9128m$$

Power of pump required = $\dot{m}gh - Equation\ 9$

$$\text{Power of pump required} = \rho A V g h - Equation\ 10$$

$$\text{Power of pump required} = (1000 \times \pi \times (0.025)^2 \times 0.25465) \times 9.81 \times 0.9128$$

$$\text{Power of pump required} = 4.47732\text{W}$$

We assume the efficiency of the pump is 50%.

$$\frac{Power\ of\ pump\ required}{Power\ input} \times 100\% = 50\% - Equation\ 11$$

$$\frac{4.47732\text{W}}{\text{Power input}} \times 100\% = 50\%$$

$$\text{Power input} = 8.95464\text{Watt.}$$

6.5.3 Flow Simulation of the water
Flow simulation of water inside the pipe.

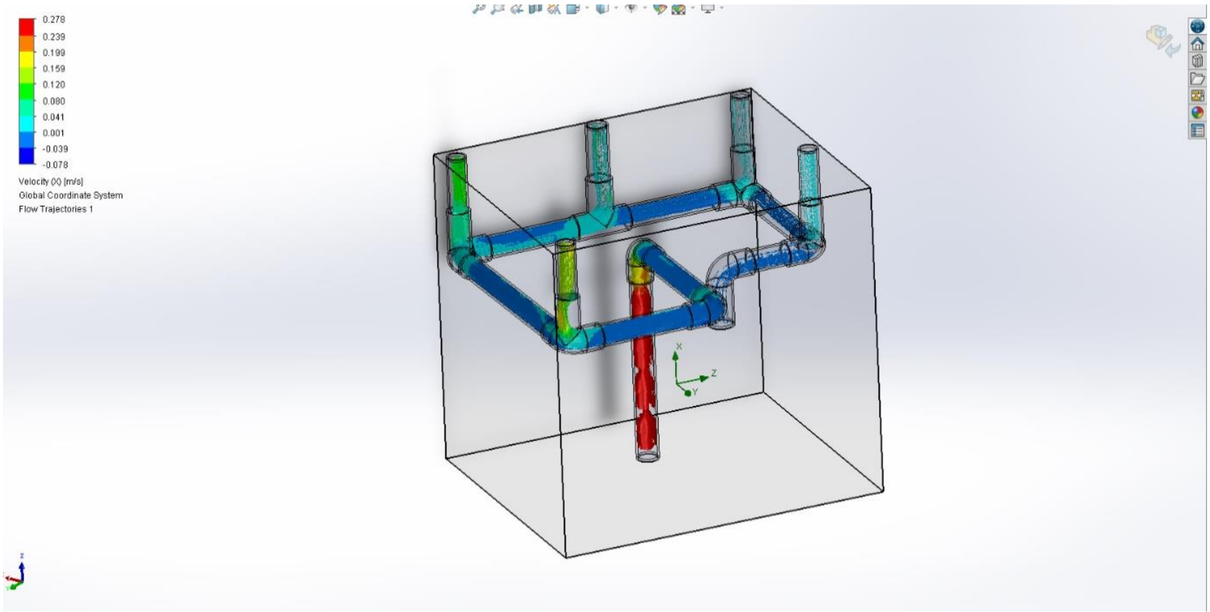


Figure 45:Flow simulation of water through the pipe.

A Solidwork feature, Flow Simulation is used to determine the water able to flow into the case module based on the power of the pump. For the prototype, we used 25Watt SOBO aquarium submersible pump. This pump is able to deliver water at the rate of 1800 litre/hour which equivalent to $0.0005m^3/s$. For the solver, it use 5236 number of cells.

Firstly, we need to create lid at every inlet and outlet of the pipe. Then proceed by setting up boundary condition for each lid and choose the type of fluid flow into the pipe. In this case, the fluid flow into the pipe is water. Then, the inlet lid is set as the volume flow rate and inlet velocity of the water which at $0.0005m^3/s$ and $0.255m/s$ respectively. At the other lid, we need to set the boundary condition as atmospheric pressure at 101.325kPa. Then, we also need to set the gravitational acceleration act on the system. For this case the gravitational acceleration is acting in negative x direction.

Based on figure 36, the water is indicated as red colour at the inlet of the pipe which means the water are flowing through the pipe at maximum speed. As the water flow through the pipe, the speed of the water flow reduces due to friction loss and energy converted to gravitational energy. As the velocity of the water decrease, the colour indicator are changed into green and blue. From the simulation result, we can clearly see the pump have enough power to supply the water into the case module.

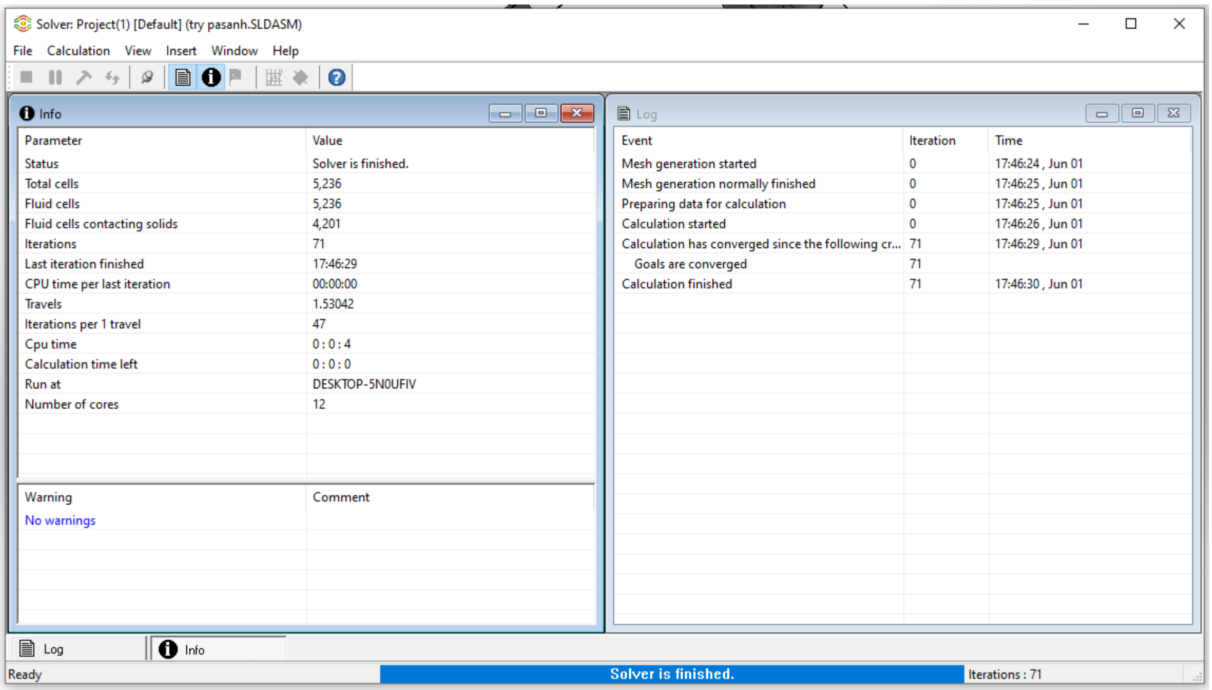


Figure 46:Data of the solver

Gravitational Settings

Table 11:Gravitational setting of the water flow

X component	-9.81 $\frac{m}{s^2}$
Y component	0 $\frac{m}{s^2}$
Z component	0 $\frac{m}{s^2}$

Material Settings

Fluids

Water

Boundary Conditions

Inlet Velocity 1

Table 12:Boundary equation for inlet velocity 1

Type	Inlet Velocity
Faces	LID34-1/Imported1//Face
Coordinate system	Face Coordinate System
Reference axis	X
Flow parameters	Flow vectors direction: Normal to face Velocity normal to face: 0.255 m/s Fully developed flow: Yes
Thermodynamic parameters	Temperature type: Temperature of initial components Temperature: 293.20 K

Environment Pressure 2

Table 13:Boundary equation for environment pressure 2

Type	Environment Pressure
Faces	LID33-1/Imported1//Face
Coordinate system	Face Coordinate System
Reference axis	X
Thermodynamic parameters	Environment pressure: 101325.00 Pa Temperature type: Temperature of initial components Temperature: 293.20 K
Turbulence parameters	Turbulence intensity and length Intensity: 2.00 % Length: 0.008 m
Boundary layer parameters	Boundary layer type: Turbulent

Environment Pressure 3

Table 14:Boundary equation for environment pressure 3

Type	Environment Pressure
Faces	LID35-1/Imported1//Face
Coordinate system	Face Coordinate System
Reference axis	X
Thermodynamic parameters	Environment pressure: 101325.00 Pa Temperature type: Temperature of initial components Temperature: 293.20 K
Turbulence parameters	Turbulence intensity and length Intensity: 2.00 % Length: 0.008 m
Boundary layer parameters	Boundary layer type: Turbulent

Environment Pressure 4

Table 15:Boundary equation for environment pressure 4

Type	Environment Pressure
Faces	LID31-1/Imported1//Face
Coordinate system	Face Coordinate System
Reference axis	X
Thermodynamic parameters	Environment pressure: 101325.00 Pa Temperature type: Temperature of initial components Temperature: 293.20 K
Turbulence parameters	Turbulence intensity and length Intensity: 2.00 % Length: 0.008 m
Boundary layer parameters	Boundary layer type: Turbulent

Environment Pressure 5

Table 16:Boundary equation for environment pressure 5

Type	Environment Pressure
Faces	LID32-1/Imported1//Face
Coordinate system	Face Coordinate System
Reference axis	X
Thermodynamic parameters	Environment pressure: 101325.00 Pa Temperature type: Temperature of initial components Temperature: 293.20 K
Turbulence parameters	Turbulence intensity and length Intensity: 2.00 % Length: 0.008 m
Boundary layer parameters	Boundary layer type: Turbulent

Environment Pressure 6

Table 17:Boundary equation for environment pressure 6

Type	Environment Pressure
Faces	LID30-1/Imported1//Face
Coordinate system	Face Coordinate System
Reference axis	X
Thermodynamic parameters	Environment pressure: 101325.00 Pa Temperature type: Temperature of initial components Temperature: 293.20 K
Turbulence parameters	Turbulence intensity and length Intensity: 2.00 % Length: 0.008 m
Boundary layer parameters	Boundary layer type: Turbulent

Environment Pressure 7

Table 18:Boundary equation for environment pressure 7

Type	Environment Pressure
Faces	LID36-1/Imported1//Face
Coordinate system	Face Coordinate System
Reference axis	X
Thermodynamic parameters	Environment pressure: 101325.00 Pa Temperature type: Temperature of initial components Temperature: 293.20 K
Turbulence parameters	Turbulence intensity and length Intensity: 2.00 % Length: 0.008 m
Boundary layer parameters	Boundary layer type: Turbulent

Min/Max Table

Table 19: Minimum and maximum value of pressure, velocity-x , velocity-y, and velocity-z

Name	Minimum	Maximum
Pressure [Pa]	97035.02	105486.77
Velocity (X) [m/s]	-0.078	0.278
Velocity (Y) [m/s]	-0.199	0.304
Velocity (Z) [m/s]	-0.311	0.105

6.5.4 Main Electronic Component

6.5.4.1 Microcontroller: NodeMCU Lua V3 ESP8266 WIFI with CH340C

Microcontroller is the brain of the system. The microcontroller we chose is based on ESP8266 WiFi System of Chip, it is also integrated with a CH340C chipset that can convert serial signals to USB. This microcontroller can function similarly to Arduino UNO but with the advantage that it does not require any external connection to the ESP8266 chip. The only drawback is that it has only one Analog I/O pin th at the developer needs to take notice of. In this project, the Analog pin is allocated for incoming signals from the moisture sensor module as it requires range mapping of analog signals into soil moisture percentage. Also, it works through communication protocols WiFi-802.11 (2.4GHz) which is available and suitable in many households use. Although it is a low cost RM15.00 Microcontroller Unit (MCU), it has dynamic memory space up to 32MB which is considered high in our application.

6.5.4.2 Soil Moisture Sensor

A soil moisture sensor consists of its module and a fork-shaped probe with two exposed conductors that go into the soil. The probe acts as a variable resistor whose resistance varies according to the soil moisture. More water in the soil means better conductivity and will result in a lower resistance and vice versa. The sensor produces an output voltage according to the resistance, which by measuring we can determine the moisture level. The module produces an output voltage according to the resistance of the probe and is made available at an Analog Output (AO) pin. The same signal is fed to a LM393 High Precision Comparator to digitize it and is made available at a Digital Output (DO) pin. The module has a built-in potentiometer for sensitivity adjustment of the digital output (DO). Apart from this, the module has two LEDs. The Power LED will light up when the module is powered. The Status LED will light up when the digital output goes LOW. To get a accurate reading of the moisture percentage, calibration needs to be done on the sensor. A variable is used to store 10-bit (2^8=1024) analog value when the soil is as dry as possible (AirValue) versus when it is completely saturated with moisture (WaterValue). AirValue is the starting point (0%) while WaterValue is the end point (100%).

6.5.4.3 Fertilizer water Level Sensor

Fertilizer water level sensor uses the same component as water level sensor, the difference is that it uses Digital signal instead of Analog signal. Thus, the calibration needs to be done physically through the twisting of screw potentiometer knob on the module. Fertilizer water level is kept HIGH state as it always exceeds the threshold value, the module will output LOW when the fertilizer water level is lower than required level.

6.5.4.4 Rain Sensor

Rain sensor works similarly to moisture sensor. The sensing pad with a series of exposed copper traces acts as a variable resistor (just like a potentiometer) whose resistance varies according to the amount of water on its surface. Water droplets on the copper traces will connects them together thus getting better conductivity and will result in a lower resistance and vice versa.

6.5.4.5 Infrared Sensor with Buzzer

The infrared sensor comes in a pair of Infrared emitter and receiver at the front of the module, whenever there is an object blocking the infrared source, it reflects the infrared, and the receiver detects it and the signal goes through a comparator circuit on board. Depending on the threshold that is adjusted, it will output logic LOW at the output pin and the green LED will light up to indicate the detection. Turning the potentiometer clock wisely will increase the sensitivity and further increase the detection range. Buzzer act as a speaker to produce audio feedback of sensor if it detects any obstacles, specifically incest or birds in our system.

6.5.4.6 WaterProof Temperature Sensor

The temperature chosen is a sealed digital temperature probe lets you precisely measure temperatures in wet environments with a simple 1-Wire interface. The DS18B20 provides 9 to 12-bit (configurable) temperature readings over a 1-Wire interface, so that only one wire (and ground) needs to be connected from a central microprocessor. A 1k Ohm resistor is used to adjust the signal levels before sending it into microcontroller.

6.5.4.7 Single Channel 5V Relay Breakout Board

As our system uses two pumps that need high voltage supply up to 12V, thus a relay is needed to separate the power supply from the microcontroller to avoid damage to the control system. The relay we used is an active-low device, means LOW state (0V) at pin IN will trigger the relay. The relay is used to intercept the high voltage power supply at Common(C) and Normally Open (NO). A LOW digital output signal sent from microcontroller to pin IN will connect the C and NO together thus complete the circuit of power supply to pump.

6.5.5 Circuit Diagram

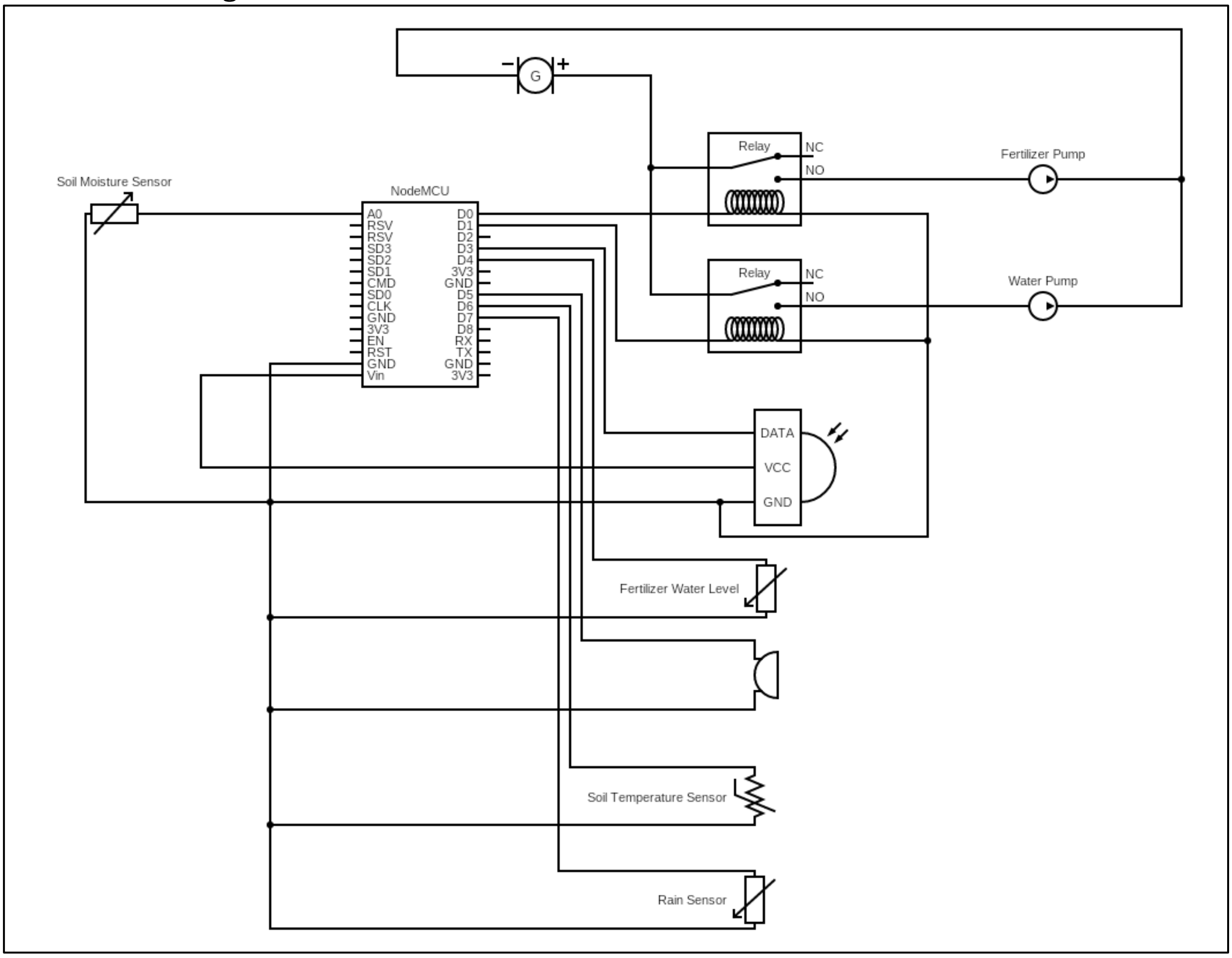


Figure 47:Circuit Diagram of Control System with Sensor

6.5.6 Programming

Table 20:Code with respective functions explanation

Code	Explanation
#include <SPI.h> **#include <ESP8266WiFi.h>** **#include <BlynkSimpleEsp8266.h>** **#include <Wire.h>** **#include <OneWire.h>** **#include <DallasTemperature.h>** **#include <Adafruit_Sensor.h>** **#include <Adafruit_GFX.h>**	Include all the library needed for Blynk Interface/ WiFi Connection, sensor Interface
char auth[] = N1jlINldA-44BEcay6DW5Xdt7Mp_4Ixn"; **char ssid[] = "KRESPO";** **char pass[] = "abcd12345";**	Declare and Define Authentication code in your Blynk Account that functions as identity card, WiFi SSID and Password for Connection purpose

#define BLYNK_TEMPLATE_ID "TMPLYbwc9A7U" #define BLYNK_DEVICE_NAME "IDP" #define BLYNK_AUTH_TOKEN "N1jlINldA-44BEcay6DW5Xdt7Mp_4Ixn" #define BLYNK_PRINT Serial #define ONE_WIRE_BUS D6 #define FertilizerPin D4 // Fertilizer Pin D4 #define buzzer D5 #define rainPin D7 OneWire oneWire(ONE_WIRE_BUS); DallasTemperature sensors(&oneWire); int rainState = 0; int lastRainState = 0; const int AirValue = 1024; const int WaterValue = 557; const int SensorPin = A0; int soilMoistureValue = 0; int soilmoisturepercent = 0; int relayFertilizer = D0; int relayWater = D1; #define pirPin D3 int pirValue; int pinValue; int fertVirValue; const unsigned long period = 5000; unsigned long startMillis = millis();	Declare and define all the Blynk Information, sensor library class member, Parameter variable name and value. Input Output Pin initiation,
BLYNK_WRITE(V0) { pinValue = param.asInt(); } BLYNK_WRITE(V5) { fertVirValue = param.asInt(); } BLYNK_CONNECTED() { Blynk.syncVirtual(V0); Blynk.syncVirtual(V5); }	Reminds microcontroller to always ensure the parameter value stored in Blynk server (Virtual Pin Value) in sync with what is stored in dynamic memory variable of MCU
void setup() { Serial.begin(115200); Blynk.begin(auth, ssid, pass); pinMode(relayFertilizer, OUTPUT); pinMode(relayWater, OUTPUT); pinMode(buzzer, OUTPUT);	Arduino **SET UP** part, only run once during every system initiation. Setting up baud rate of MCU and serial monitor, MCU Digital

pinMode(FertilizerPin, INPUT_PULLUP); sensors.begin(); // Dallas temperature }	Pin Mode, class member initiation
LOOPING PART where the code keeps on running as a whole Loop	
void getPirValue(void) { pirValue = digitalRead(pirPin); if (not pirValue) { Serial.println("Motion detected!!!"); Blynk.notify("Motion detected in your farm") ; digitalWrite(buzzer, HIGH); delay(1000); digitalWrite(buzzer, LOW); delay(1000); digitalWrite(buzzer, HIGH); delay(1000); digitalWrite(buzzer, LOW); delay(1000); } else { Serial.println("No Motion."); Blynk.notify("No Motion detected in your farm") ; }	Function to read the state from Infrared sensor and determine whether the actuator, in this case buzzer to sounds. At the same time, Update the value in the Blynk Interface. This function only activated when the button of Infrared function is activated in the Blynk User Interface
sensors.requestTemperatures(); float temp = sensors.getTempCByIndex(0); Serial.println("Soil Temperature: "); Serial.print(temp); Serial.print(" "); Serial.println("C"); Blynk.virtualWrite(V2, temp); //Dallas Temperature	Calling OneWire and Dallas Temperature library member function and update the sensed state to Virtual Pin of Blynk Server to store that value.
soilMoistureValue = analogRead(SensorPin); Serial.println("Soil Moisture Value: "); Serial.println(soilMoistureValue); soilmoisturepercent = map(soilMoistureValue, AirValue, WaterValue, 0, 100); Blynk.virtualWrite(V1, soilmoisturepercent);	Reading analog value from soil moisture sensor during fully wet soil and dry soil then remap it into 0 to 100 percent
if (soilmoisturepercent > 100) { Serial.println("Soil Moisture% = 100 %"); } else if (soilmoisturepercent < 0) { Serial.println("Soil Moisture% = 0 %"); }	Logic control of the water pump based on the soil moisture percentage. The threshold level is set to 45% whether the MCU will send 0 state to relay at Digital Pin 1 so that the power can be supplied to water pump.

`` else if (soilmoisturepercent >= 0 && soilmoisturepercent <= 100) { Serial.println("Soil Moisture% = "); Serial.print(soilmoisturepercent); Serial.println(" %"); } if (soilmoisturepercent >= 0 && soilmoisturepercent <= 45) { Serial.println("Needs water, send notification !!!"); Blynk.notify("Plants need water... Pump is activated"); digitalWrite(relayWater, LOW); Serial.println("Pump is ON"); } else if (soilmoisturepercent > 45 && soilmoisturepercent <= 100) { Serial.println("Soil Moisture level looks good..."); digitalWrite(relayWater, HIGH); Serial.println("Pump is OFF"); } else{ Serial.println("Soil Moisture% larger than 100%"); } ```	
`` rainState = digitalRead(rainPin); Serial.println("Rainstate: "); Serial.println(rainState); if (rainState == 0 && lastRainState == 0) { Serial.println("It's Raining outside!"); Blynk.notify("It's Raining outside!") ; WidgetLED led1(V3); led1.on(); lastRainState = 1; } else if (rainState == 0 && lastRainState == 1) { delay(1000); Serial.println("Still Raining!"); } else { Serial.println("No Rains..."); WidgetLED led1(V3); led1.off(); lastRainState = 0; ```	Rain sensor initiation. After doing computation, the rain state will be sent to Blynk Server. If it is raining, the code will trigger the LED widget in the Blynk User Interface to light up. Also, for registered user in this IDP Project device, a real time notification will be sent to Blynk App.

}	
int fertilizerState = digitalRead(FertilizerPin); Serial.println("Fertilizer State: "); Serial.println(fertilizerState); if (fertilizerState == 0) { Serial.println("Fertilizer is enough."); Blynk.notify("Fertilizer is enough.") ; WidgetLED led2(V4); led2.on(); } else if(fertilizerState == 1){ Serial.println("Fertilizer is depleted, please replenish!!!"); Blynk.notify("Fertilizer is depleted, please replenish!!!") ; WidgetLED led2(V4); led2.off(); }	Keeps on sensing the fertilizer water level. The LED widget in Blynk User Interface will keep on light up as long as the fertilizer is adequate. If it is lower than the threshold level, a HIGH state will be sent to MCU, MCU will then trigger the LED to lights OFF and a notification will be sent to registered user Blynk App.
Serial.println("Fert Pump Virtual Pin: "); Serial.println(fertVirValue); if (fertVirValue == HIGH) { unsigned long currentMillis = millis();// store the real time digitalWrite(relayFertilizer, LOW); delay(period); digitalWrite(relayFertilizer,HIGH); delay(55000); } else{ digitalWrite(relayFertilizer,HIGH); }	Automation features is used where it will trigger V5 Virtual Pin to be HIGH once a week during a specific time (based on user setting) for 1 minute. The code will read the virtual Pin value from the Blynk Server and trigger MCU to send a LOW state to relay thus complete the circuit connection of Fertilizer Pump.

6.6 The used of Modern Tools

6.6.1 Blynk – IoT Development Platform

Blynk is a full suite of software required to prototype, deploy, and remotely manage connected electronic devices at any scale: from personal IoT projects to millions of commercial connected products. With Blynk anyone can connect their hardware to the cloud and build a no-code iOS, Android, and web applications to analyze real-time and historical data coming from devices, control them remotely from anywhere in the world, receive important notifications, and much more. Blynk is a multi-tenant solution. You can configure how users get access to the data by setting roles and configuring permissions which will later be explained in **6.5.3 User Integration into System**. Applications made with Blynk are ready for the end-users. Whether it is your family member, an employee, or someone who has purchased your product, they will be able to download the app, connect the device and start using it after they registered a FREE user account in https://blynk.io/ . Blynk also offers a white-label solution (part of the Business Plan), which means that you can add your company logo, app icon, choose the theme, colours, and publish the app to App Store and Google Play under your company name. These apps will work with your devices which we will not use in our project due to budget constraints.

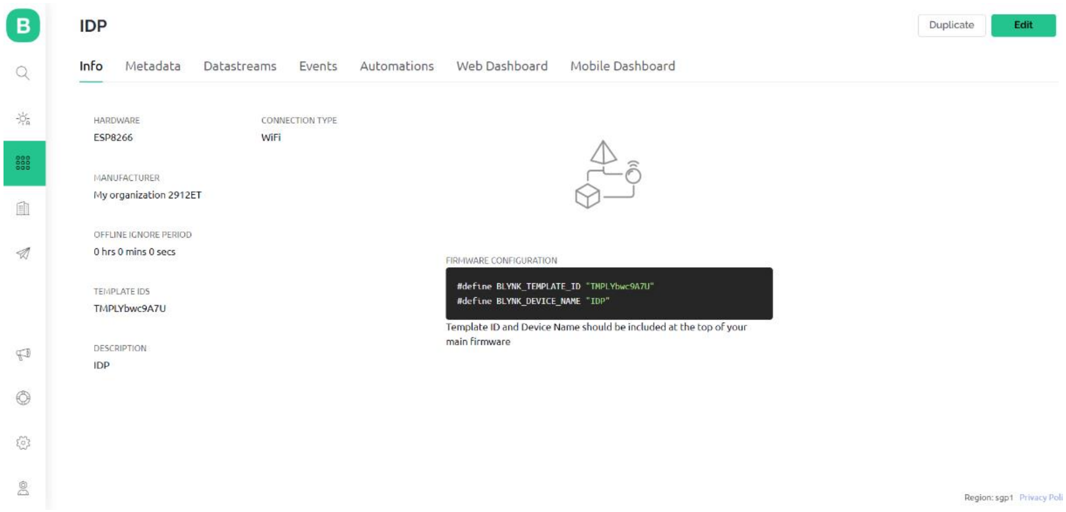


Figure 48:IDP Template Info in Blynk

In Blynk, a device Templates is used to make it easy to work with multiple devices that perform the same functions. Our IDP project works under a template but in the device level, it has specific Blynk Authentication Token that differentiate it from other devices.

After setting up the Blynk template, the next step is to add the Datastream and store it into a Virtual Pin for each DataStream created. Datastream acts the same way as a variable in programming to store certain values either in integer, double, or string form.

Search datastream

Id	Name	Alias	Color	Pin	Data Type	Units	Is Raw	Min	Max	Decimals	Default Valu
1	Soil Moisture	Soil Moisture		V1	Integer	%	false	0	100	–	
2	Soil Temperature	Soil Temperature		V2	Double	°C	false	0	100	#.##	
4	Infrared	Infrared		V0	Integer		false	0	1	–	
5	Rain	Rain		V3	Integer		false	0	1	–	
6	Fertilizer Level	Fertilizer Level		V4	Integer		false	0	1	–	
7	Fertilizer Pump	Fertilizer Pump		V5	Integer		false	0	1	–	0

Figure 49:DataStream created for the System and respective Virtual Pin value

Virtual Pin are a Blynk abstraction designed to exchange any data between your hardware and Blynk. Anything you connect to your hardware will be able to talk to Blynk. With Virtual Pins you can send something from the App, process it on the microcontroller, and then send it back to the smartphone. You can trigger functions, read I2C devices, convert values, control servo and DC motors etc. Virtual Pins can be used to interface with external libraries (Servo, LCD, and others) and implement custom functionality. In the project, Virtual Pins are used to communicate with Input/ Output Pin.

Datastream is also important for the usage of widget in Blynk to create the Web Dashboard and Mobile App Dashboard as the widget such as switch, label, chart and so on read data/ state from Datastream. Widget are drag and drop features prepared by Blynk to help developers design and create the user interface based on their preferences.

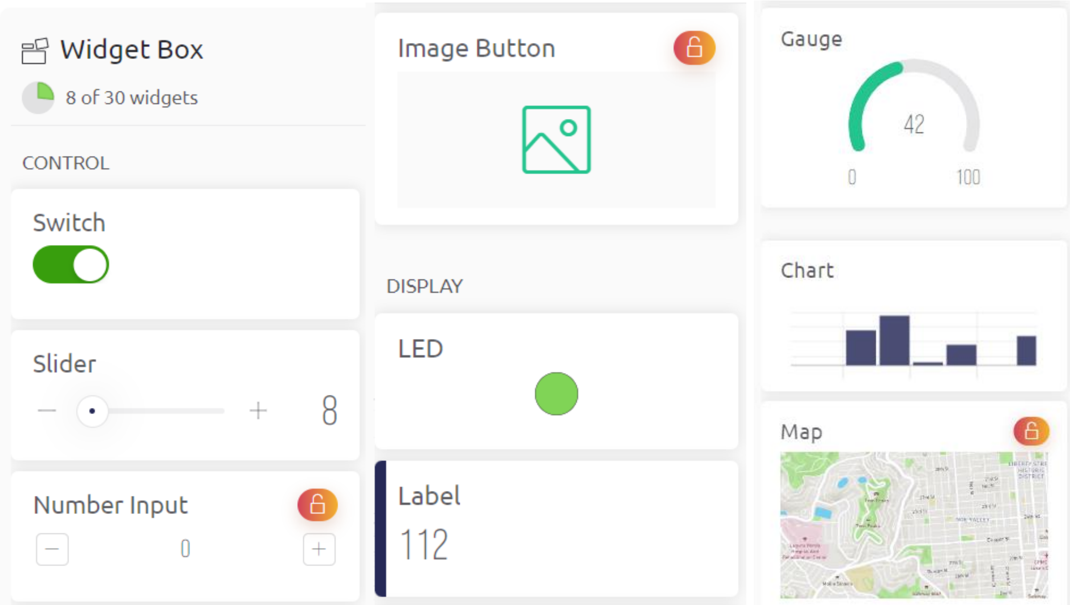


Figure 50:Example of Widgets in Blynk

Blynk is an attractive platform for IoT development, as free user that did not spend any money on service subscription, we are still able to get a real time data update in the designed user interface. The data transmission starting from the data obtained through sensor to MCU and then to Virtual Pin that act as a container to store the data temporarily in the server is fast without any intermittency or leakage.

Some widget features provided also enable user control on the system remotely such as switch control on the infrared sensor so the Anti Pest Control via Infrared Sensor and Buzzer can be turned off during night. There is also LED Indicator as signal of fertilizer water level adequacy, raining state and so on.

6.6.2 Blynk Automation

6.6.2.1 Blynk Automation in NOTIFICATION

There are 4 types of Automation that can be done through Blynk. First, SCHEDULE where automation will start at a specified time of day. Second, SUNSET/ SUNRISE where automation will start based on the sun. Third, DEVICE STATE where Device Virtual Pin under certain STATE will act as a trigger to initiate the automation. Lastly, SCENE that trigger the automation manually by using button or switch widget on interface.

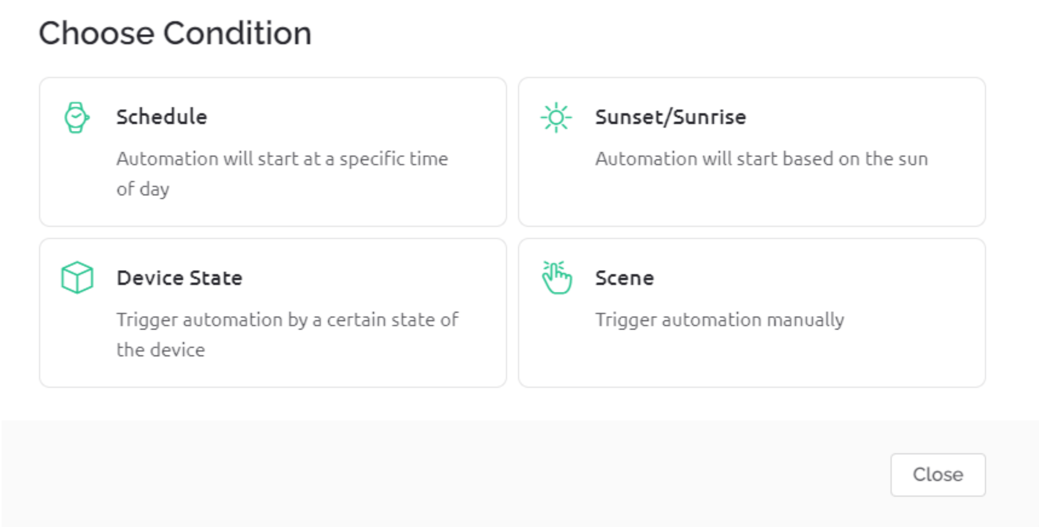


Figure 51:Types of Automation Available in Blynk

In our system, we have used the third type of automation (DEVICE STATE) to do some automation features such as Rain Alert where the Raining status will be sent to user registered Blynk account email and signed in Mobile Application. Also, we created a Fertilizer Level depleted warning automation to be sent to user registered Blynk account email and signed in apps as we think that user might not watching the User Interface all the time so they might miss out the warning shown by LED indicator.

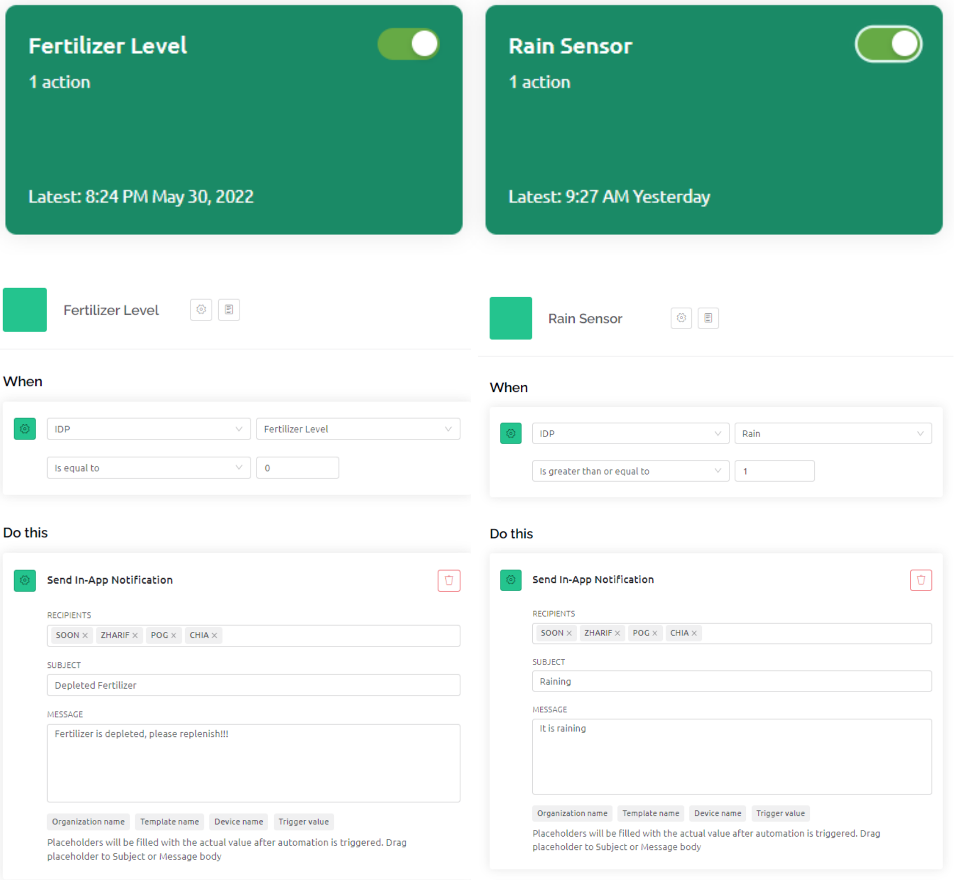


Figure 52:Rain Alert and Fertilizer Level Warning Automation (DEVICE STATE)

6.6.2.2 Blynk Automation in ACTUATOR CONTROL

Our system consists of 2 actuators are Water Pump and Fertilizer Pump which both required a 12V power supply and are separated from the main system circuit connection via relay. The water pump controls the water flow to the peat moss, and it is based on the soil moisture level without Blynk Automation.

However, actuator control of Fertilizer pump is based on SCHEDULE, fertilizer solution will be pumped into the peat moss for 5 seconds once a week. For that specific 1-minute period, Virtual Pin that store Fertilizer Pump State will be HIGH, the state will be detected by MCU and MCU will then send a LOW state to digital pin 0 so the relay can be activated for 5 seconds.

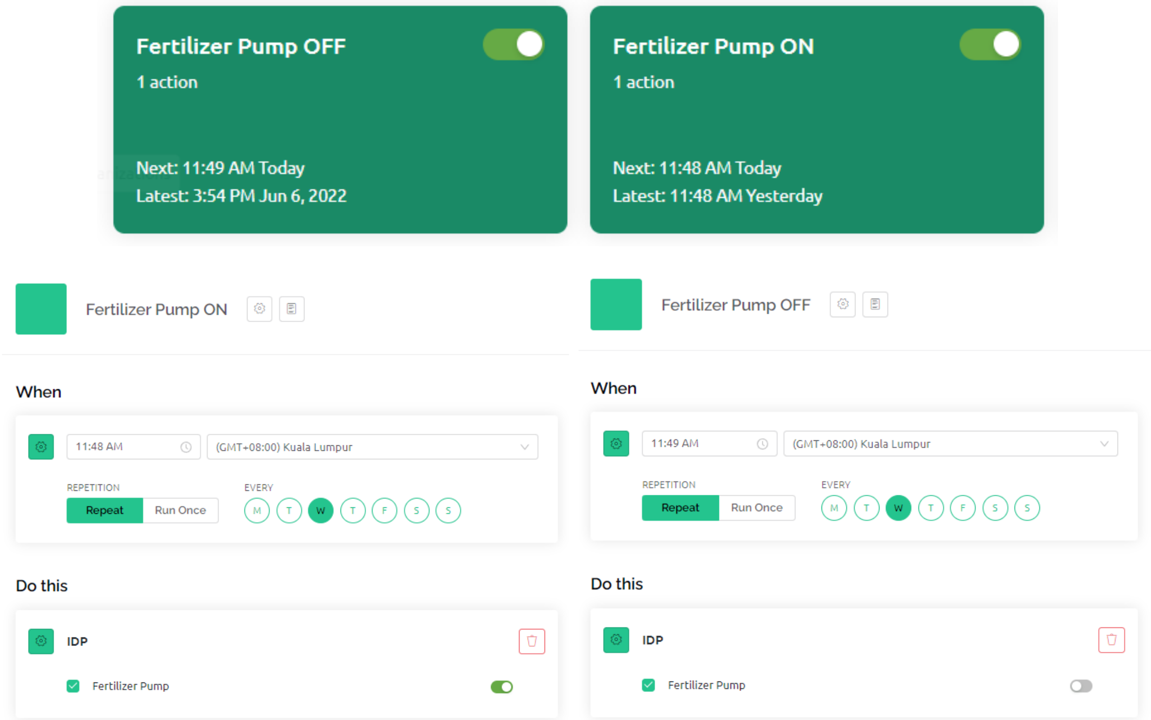


Figure 53:Fertilizer Pump Automation (SCHEDULE)

6.6.3 User Integration into System

6.6.3.1 Registration into Blynk IDP Device

Developer account will be recognized as administrative account (Admin) automatically. Next, admin can invite new users to register an account either as staff or user. The hierarchy level in Blynk is Admin > Staff > User. The information needed to register account are a new username, a valid email for confirmation, and a phone number.

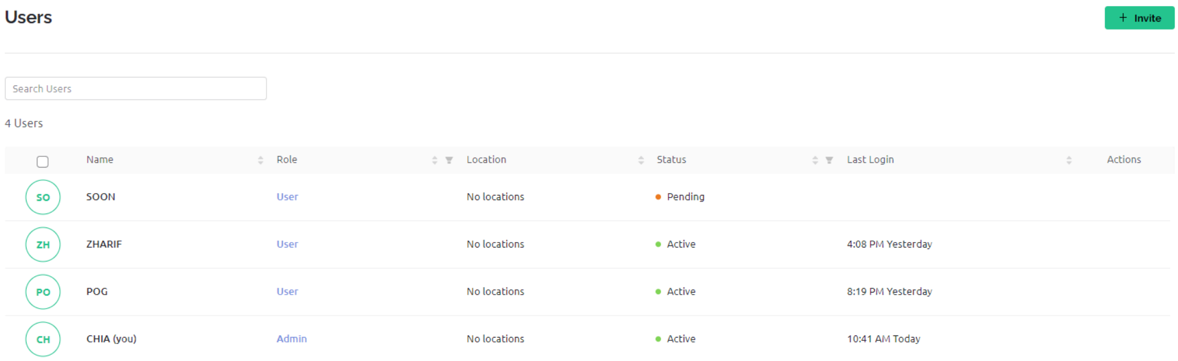


Figure 54:List of Users in IDP Device

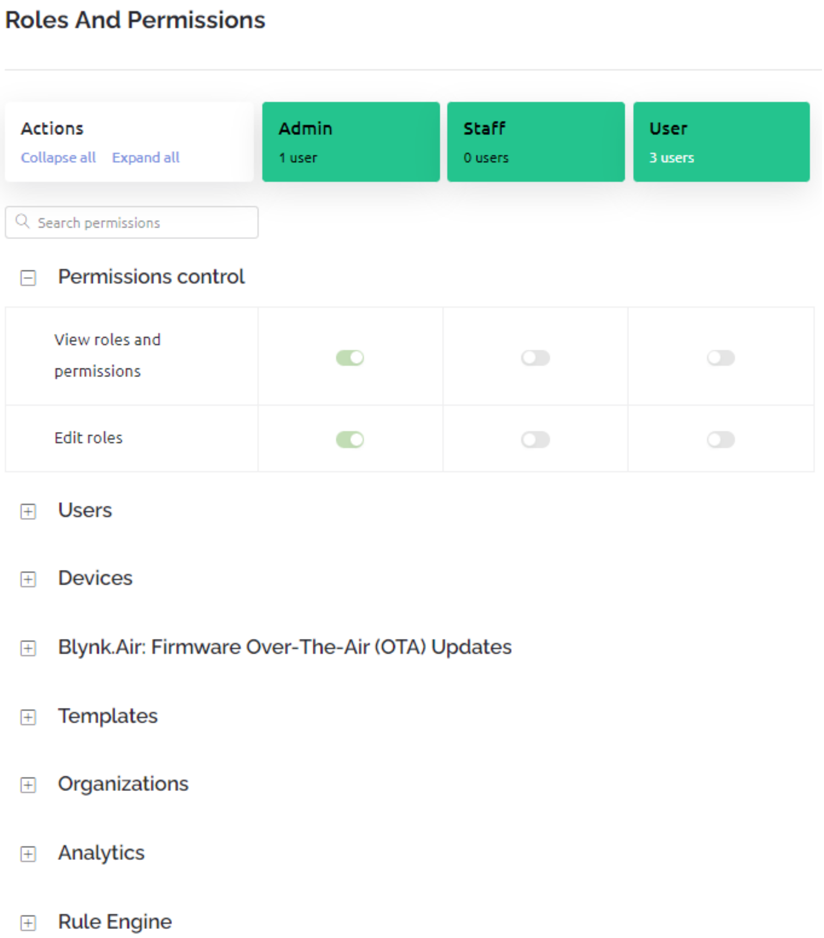


Figure 55:Roles and Permissions of Users in the system

6.5.3.2 Limitation

As the service package we are using are free of charge. Some limitation existed during the development of the IoT system. Firstly, the main drawback is that the maximum allowable account to be registered into the system is only 5 including the admin. Also, admin is not allowed to freely edit the permission control of other roles. Also, the widgets given to Developer for designing web and mobile apps dashboard are the basic widgets and have limited function. For example, the data from the chart cannot be exported into excel and sent to email for further data analysis to improve the parameter accuracy. If taken manually, there will be human error and it will be a time-consuming process.

Although our main project aim is carefree smart farming, however it still requires some simple manual maintenance through human effort such as replenish the big water tank supply and fertilizer solution compartment. Also, as we did not install any water removal features in the system, we still need to be aware of heavy rain that might cause the water overflow in Peat Moss. Thus, that is the reason where Blynk Apps notification for raining is developed so actions can be taken by user when there is critical raining condition. However, this does not affect the marketability of this project as the possibility of indoor balcony flood due to rain is very low.

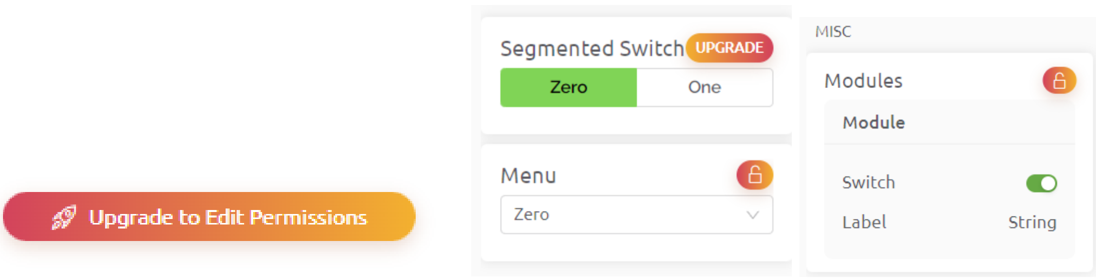


Figure 56:Free User Limitation Features Examples

CHAPTER 7: PROJECT MANAGEMENT AND ECONOMIC FEASIBILITY

7.1 Risk Management

Table 21:Risk of failure of this project.

NO	RISK	DESCRIPTION	SOLUTION
1	Body Fracture/Crack	• The acrylic sheet may fracture or crack due to external force applied to the prototype or due to wrong method of acrylic cutting during initial process	• The fractured part can be replaced with new acrylic sheet • The crack can be sealed by silicon sealant
2	Water leaking	• Even if no crack or fracture exist, the platform still can leak at the edge of the sheets if the sealant is not applied smoothly and thoroughly	• We need to reapply the silicone sealant by removing the old ones or just clog the defects to avoid leaking
3	Plants' growth	• The plants may not grow healthy as expected	• Need to monitor manually the plants to make sure the water level, nutrient and

			sunlight is enough for optimum growth
4	Short Circuit	• The wire connection on the breadboard may wrongly place/connect that can lead to short circuit and system failure when supplied with voltage	• Make sure the connections are at right place and terminal before supply the voltage
5	Electronic Component failure	• The components such as sensors, relays, buzzer, and ESP8266 may not be functioning at long term period of the project • The component may have unseeable defect from the factory	• Make sure the components are not expose to surrounding that can ruin the components internally • Make sure we have back up component in case we have any defect of the original ones.
6	Wi-Fi connection latency	• Wi-Fi connection to ESP8266 may fluctuating according to the signal strength or the environment of the microcontroller unit	• Make sure the source of Wi-Fi (personal hotspot) is near the ESP8266 to increase the signal strength
7	Base Support failure	• This base structure may not strong enough to support the prototype weight or external weight from the pests or bird that stand on the prototype.	• Make sure the base structure was made of PVC pipe connected together with PCV solvent. • Construct the base with a high stability and high strength shape or geometry
8	Programming error	• Due to lack of experience in programming language, the coding used/developed may not well created to be implied in this prototype. • There might occur some bug during the execution of program	• Do a lot of research and exercise about the computer language used to minimalize the error during running the program. • Always improvise the programming

		• Coding may not execute exactly as we want it to be that can create an error	according to the issue face during execution.

7.2 Resource

Table 22: Resource of this project team

NO	NAME	MATRIC NUMBER	POSITION	DESCRIPTION
1	CHIA WEN HAN	17206032	Leader Main Programmer	• Leader of the project • Organize meetings weekly with supervisor to - review progress changes - distribute assignment for each group member - discuss and exchange opinion about the product with supervisor • Lead the progression of weekly meetings, weekly assignment, guide the overview of report writing and group presentation, and supervise the prototype development • Develop programming algorithm • Write Arduino coding for smart system • Develop circuit connection • Conduct sensor calibration • Construct IoT system
2	AHAMAD ADZAM PUTRA BIN AHAMAD	17205479	Project Narrator Project Manager	• Poster Design of the team • Report and slides touch up and checking • Develop Gantt Chart and Work Plan for both semester • Constant Monitoring of Project Progress to avoid slack off in critical path • Audit the financial usage in the team
3	MUHAMMAD FIKRI BIN MISNADI	17204059	3D Cad Designer	• Hand sketch on preliminary design • Create 3D prototype design based on customers' needs. • Design simulation • Strength analysis of all the machine element • Stress/Load analysis of drying rack

				• Factor of safety • Assist in all the Programming related tasks
4	SOON WEE TECK	17207506	Treasurer	• Handling budget and resources. • Research on the product availability and material of the product in the market • Market survey • Plan, execute and record all outstation team meeting • Record all proof of procurement for documentation • Paperwork handling of the team including submission of claim
5	MUHAMMAD ZHARIF BIN MAD SHUKRI@FAZLI	17166667	Prototype Constructor Trouble-shooter	• Research on the selection of material used • Selection of pump and motor for based on the calculation • Research on the machining and assembly process using power tool • Guide and lead other group members during prototyping phase • Assist in all the 3D Design related tasks

7.3 Budget/ Cost

In this section of the report, we will look at the budget and the costing of the Integrated Design Project (IDP) prototype. First thing first, we have several parts in this section, which are:

1. List of bought component/material
2. List of existing component/material
3. Actual cost of prototype

In Part 1, we did market research regarding the price of the required component/material in three different shops (Shopee, Lazada and Others). For Shopee and Lazada, the price stated does not include the delivering fees of RM4.50 (depends on courier) but we manage to find a cheaper and faster way to obtain the materials from the 'Others' store as it is mostly from nearby store around University of Malaya. In this part, we use about RM462.33 of the budgets provided (RM500) by the faculty due to the imperfection of our initial prototype during early Semester 2. So, to reconstruct a new prototype, we need to buy new component/material from the store. The reason behind our purchase of these components or parts are mostly because of the cheap option and a fast shipment for those components consecutively as we don't have enough time for a long-distance shipment hence, we need to sacrifice some extra cost for some component.

In Part 2, some of our group members are already have the need component for the prototype that need to be constructed. Hence, we listed the items that we have before we buy the other item that we need. We manage to save about RM62.15 from the provided budget.

In Part 3, we listed the final component/material that we actually used for the finished prototype to be totalled of RM356.51 including the price of existing component (RM62.15). This is calculated to be RM105.82 less than total cost used to buy the needed component. Some of the items may not be seen in construction of the prototype, but for the initial process before construction, we use them such as for momentary places for plants, maintenance of the prototype, storage purpose, etc.

From our calculations, the commercial value of our product in the market will be around RM500.00 per meter square of crop including installation of the product. The total cost for making a single unit is RM356.51 to be exact. Hence, the net profit we obtained from every unit is RM143.49 per meter square which is 40.24% from the total cost to produce one unit. To compare with our competitor regarding the price, our product is much higher to compare with Smart Tani's product which is roughly RM200 per meter square. If we subtract the prototype component and replace it with a real application components, we can reach a minimum price of RM300 per meter square002E Even with the different value of prices, our product is much more efficient as compare to them.

To justify the excessive cost of our product, we manage to come out with few reasons. Firstly, our latest prototype held in a container with is costly but in the real application, we will use an open space of land, so that will reduce the cost of this project. Secondly, since we use an open space for our project, we may not use some of the part that we buy such as the peat moss, Silicone sealant, plant tray, etc. That also will reduce a lot of cost for this project. Although the cost will be reduced from the components used, we may need to to increase the cost as the real applications need to use bigger components and better-quality materials such as a bigger and prowerful pumps, better piping systems and a higher quality nutrient. So we might need to prepare for a better cost and financial support for this project to be executed in real life application.

The proofs such as receipt and invoice of purchasing for all components/materials are compile in PDF and JPG in Google Drive link provided:

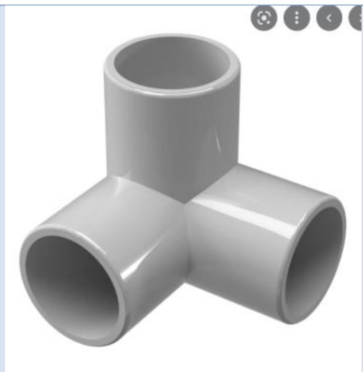
https://drive.google.com/drive/folders/1JVA7V2R2EMcA-V2aMtrCunGYIbtal4Pk?usp=sharing

7.3.1 List of Bought Component/Material

Table 23: List of bought material

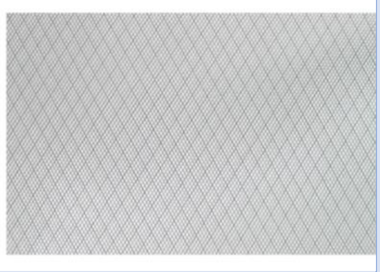
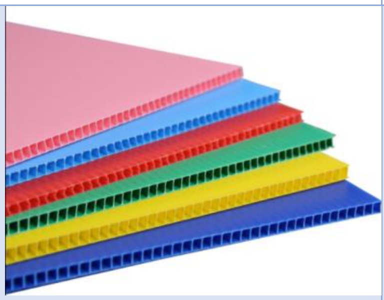
No.	Name of Component	Picture of Component	Quantit y	Shop Title	Price per Unit (RM)	Total (RM)

1	Plant Tray		1	kdhplantworld	5.90	5.90
				Tip Top Gardening	7.51	7.51
				TOTPLANTS HORTICULAR CENTRE	**4.00**	**4.00**
2	Peat Moss		1	mdrazman	10.00	10.00
				Garden Rabbit	12.00	12.00
				TOTPLANTS HORTICULAR CENTRE	**8.00**	**8.00**
3	Chili Seeds		1	saifagmartstore	5.00	5.00
				Mango Garden Malaysia	5.00	5.00
				TOTPLANTS HORTICULAR CENTRE	**3.50**	**3.50**
4	Hacksaw		1	ylkmarketing	10.00	10.00
				WT HOUSEHOLD	9.99	9.99

				MR. DIY	**7.50**	**7.50**
5	Cable Tie		2	minglighting	5.50	11.00
				SGB HARDWARE SDN BHD	2.20	4.40
				MR. DIY	**2.00**	**4.00**
6	PVC Pipe Class 6 20mm (8 ft)		1	wcphardware	24.00	24.00
				Proeast Kepong	22.00	22.00
				SIN TUCK WOH HARDWARE PJ SDN BHD	**23.00**	**23.00**
7	20mm 3 ways elbow		8	survivalkit	5.20	41.60
				YESPERY	5.10	40.80
				SIN TUCK WOH HARDWARE PJ SDN BHD	**3.45**	**27.60**
8	PVC Tee 20mm		1	yksharware official	3.80	3.80
				SNL Enterprise	1.20	1.20

				SIN TUCK WOH HARDWARE PJ SDN BHD	**1.20**	**1.20**
9	PVC Elbow 20mm		9	yksharware official	1.80	16.20
				Majujaya Hardware Shop	0.99	8.91
				SIN TUCK WOH HARDWARE PJ SDN BHD	**0.90**	**8.10**
10	Solvent Cement 100g		1	yksharware official	4.00	4.00
				Majujaya Hardware Shop	5.80	5.80
				SIN TUCK WOH HARDWARE PJ SDN BHD	**4.00**	**4.00**
11	White PTFE Tape		3	jxdiyspecialist	0.84	1.68
				ON ELECTRONIC AND HARDWARE ENTERPRISE	0.60	1.20
				SIN TUCK WOH HARDWARE PJ SDN BHD	**0.60**	**1.80**
12	MT Waterproof		2	yksharware official	0.62	1.24

	Sandpaper s100			Bang Heng Hardware 1586415787	0.74	1.48
				SIN TUCK WOH HARDWARE PJ SDN BHD	**1.00**	**2.00**
13	Sobo Aquarium Submersible Pump WP200D		1	**GMS KL**	**35.40**	**35.40**
				Aquaponics & Urban Growing Supplies	49.00	49.00
				Suzana_sulaiman	38.90	38.90
14	Chili Seed		1	saifagmartstore	5.00	5.00
				Mango Garden Malaysia	5.00	5.00
				LenSeng Nursery	**5.00**	**5.00**
15	Flowerpot tray		1	myhome2garden	6.90	6.90
				Dadaun	9.90	9.90
				LenSeng Nursery	**10.00**	**10.00**
16	PVC Pipe Class 6 20mm (3m)		1	wcphardware	27.00	27.00
				Proeast Kepong	24.75	24.75
				SIN TUCK WOH HARDWA	**15.50**	**15.50**

				RE PJ SDN BHD		
17	Mosquito PVC Netting 4 Meter		1	futtkongmarketting	15.60	15.60
				Able Moment	8.33	8.33
				SIN TUCK WOH HARDWARE PJ SDN BHD	**6.00**	**6.00**
18	Tulips Cotton Ball 50s CB50 White		2	gcommerce	5.00	10.00
				ZEN PHARMACY	6.00	12.00
				MR DIY (KUCHAI) SDN BHD	**2.20**	**4.40**
19	Polyplast Board BE5		1	hivesmith	10.50	10.50
				Silken Splash	7.50	7.50
				TANJONG MAS BOOKCENTRE (PJ) SDN BHD	**11.10**	**11.10**
20	Silicon Tube		1	peterlaupik	2.00	2.00
				FAE Supply	4.00	4.00
				IRENE AQUARIUM & PET SDN BHD	**2.00**	**2.00**

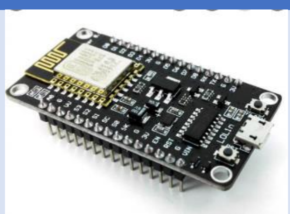
21	Acrylic Sheet A2 2mm		7	**ds_8128**	**22.00**	**154.00**
				Zuiver Craft Sdn Bhd	26.90	188.30
				khangcheng	28.00	196.00
22	Adhesive Silicone (Xtraseal)		1	**88hardware**	**6.88**	**6.88**
				AZ Bestbuy Store	8.00	8.00
				MR DIY	11.30	11.30
23	12V Solenoid Valve – ¾ Inches (SV-12V-34)		1	Cancanshop .my	9.97	9.97
				Techmanistan	50.83	50.83
				CYTRON TECHNOLOGIES SDN BHD	**62.40**	**62.40**
24	Single channel 5v Relay Breakout Board (BB-RELAY-5V-01)		2	Kingzizi.my	5.00	5.00
				Autobotic sdn bhd	7.00	7.00
				CYTRON TECHNOLOGIES SDN BHD	**5.00**	**10.00**
25	DC jack (Female) to Screw terminal adapter (CN -126F-DF)		1	Electrica.my	2.50	2.50
				Autobotic sdn bhd	3.00	3.00

				**CYTRON TECHNOLOGIES SDN BHD**	**2.00**	**2.00**
26	Adapter 12V 1A (UK Plug) (AD-12-1)		1	Victop.victop	10.50	10.50
				MEEGO MALL	9.19	9.19
				CYTRON TECHNOLOGIES SDN BHD	**7.58**	**7.58**
27	Crocodile Clip with wire (10pcs) (WR-CC-10)		1	techmakers	6.40	6.40
				Autobotic Sdn Bhd	6.50	6.50
				CYTRON TECHNOLOGIES SDN BHD	**6.37**	**6.37**
28	Acetal R Socket 20mm X 15mm 'SH'		**2**	rafechico	2.63	5.26
				SNL Enterprise	2.20	4.40
				SIN TUCK WOH HARDWARE PJ SDN BHD	**2.30**	**4.60**
29	KC Nipple ½"		**2**	Lawrence27	4.00	8.00
				T.N MACHINERY HARDWA	3.00	6.00

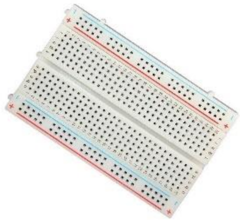
				RE SDN BHD		
				SIN TUCK WOH HARDWARE PJ SDN BHD	**3.00**	**6.00**
30	Orbit Hose Clips 13mm-19mm (1/2”)		**2**	Global.pro	1.60	3.20
				AMAN 020 SDN BHD	1.70	1.70
				SIN TUCK WOH HARDWARE PJ SDN BHD	**1.30**	**2.60**
	Peat Moss		2	mdrazman	10.00	20.00
				Garden Rabbit	12.00	24.00
				LOTUSS STORE	**7.90**	**15.80**
TOTAL COST (Highlighted Only)						462.33

7.3.2 List of Existing Component/Material

Table 24: List of existing component

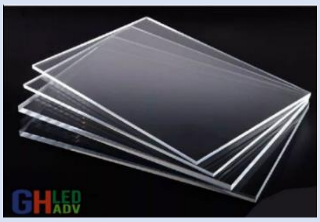
No.	Name of Component	Picture of Component	Quantity	Price per Unit (RM)	Total (RM)
1	NodeMCU Lua V3 ESP8266 WIFI with CH340C		1	14.30	14.30

2	Moisture Sensor Module		2	5.00	10.00
3	Rain Sensor Module		1	5.00	5.00
4	Infrared Sensor Module		1	1.90	1.90
5	Waterproof temperature sensor		1	7.84	7.84
6	Resistor 1k Ohm		1	0.05	0.05
7	Buzzer		1	0.70	0.70
8	Jumper wire (Male to Male)		1	4.50	4.50

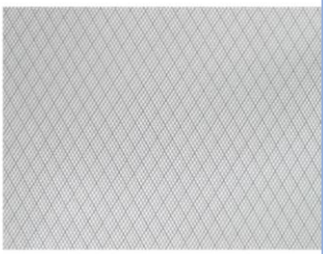
9	Jumper wire (Female to Female)		1	2.00	2.00
10	Breadboard 8.5x5.5cm (400 Holes)		2	2.70	5.40
11	R385 DC12V Diaphragm Water Pump		1	10.46	10.46
	TOTAL COST				**62.15**

7.3.3 Actual Cost of Prototype

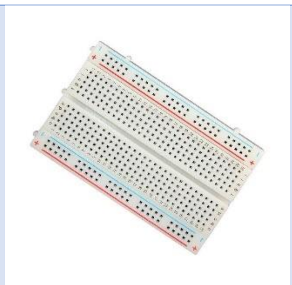
Table 25: Actual cost of the prototype

No.	Name of Component	Picture of Component	Quantity	Price per Unit (RM)	Total (RM)
1	Acrylic Sheet A2 2mm		7	22.00	154.00
2	Peat Moss		3	7.90 (8.00)	23.80

3	20mm 3 ways elbow		8	3.45	27.60
4	PVC Tee 20mm		1	1.20	1.20
5	PVC Elbow 20mm		9	0.90	8.10
6	Plant Tray		1	4.00	4.00
7	Solvent Cement 100g		1	4.00	4.00

8	White PTFE Tape		3	0.60	1.80
9	Sobo Aquarium Submersible Pump WP200D		1	35.40	35.40
10	Mosquito PVC Netting 4 Meter		1	6.00	6.00
11	Silicon Tube		1	2.00	2.00
12	Adhesive Silicone (Xtraseal)		1	6.88	6.88
13	Single channel 5v Relay Breakout Board (BB-RELAY-5V-01)		2	5.00	10.00

14	Adapter 12V 1A (UK Plug) (AD-12-1)		1	2.00	2.00
15	Adapter 12V 1A (UK Plug) (AD-12-1)		1	7.58	7.58
16	NodeMCU Lua V3 ESP8266 WIFI with CH340C		1	14.30	14.30
17	Moisture Sensor Module		2	5.00	10.00
18	Rain Sensor Module		1	5.00	5.00
19	Infrared Sensor Module		1	1.90	1.90

20	Waterproof temperature sensor		1	7.84	7.84
21	Resistor 1k Ohm		1	0.05	0.05
22	Buzzer		1	0.70	0.70
23	Jumper wire (Male to Male)		1	4.50	4.50
24	Jumper wire (Female to Female)		1	2.00	2.00
25	Breadboard 8.5x5.5cm (400 Holes)		2	2.70	5.40
26	R385 DC12V Diaphragm Water Pump		1	10.46	10.46
	TOTAL COST				**356.51**

7.4 Work Plan (Gantt Chart)

7.4.1 Gantt Chart Semester 1

Table 26: Gantt Chart for semester 1

No	Activity	Start	End	Semester 1													
				1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	IDP Briefing from coordinator	1	1														
2	Brainstorm idea with group member	1	1														
3	Develop project concept and idea	1	1														
4	First presentation to supervisor	1	2														
5	Adjustment on the idea and concept	2	2														
6	Second meeting with supervisor	3	3														
7	Develop project proposal	3	4														
8	Material and budget survey	4	5														
9	Third Meeting with supervisor	5	5														
9	Develop detailed design of project	6	7														
10	Develop Solidwork / Matlab model	6	8														
11	Fourth Meeting with supervisor	8	8														
12	Analyse issue based on the model designed	9	11														
13	Fifth meeting with supervisor	11	11														
14	Final check and touch up before presentation	12	12														
15	Presentation the idea and Q&A	13	14														

7.4.2 Gantt Chart Semester 2

Table 27: Gantt Chart for semester 2

No	Activity	Start	End	Semester 2													
				1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Purchase of parts and first discussion with supervisor	1	1														
2	Installation and assembly of parts	2	7														
3	Code the Arduino	2	4														
4	Second meeting with supervisor	4	4														
5	Do refinement on the prototype	4	8														
6	Third meeting with supervisor	6	6														
7	Testing the prototype	8	9														
8	Fourth meeting with supervisor	9	9														
9	Final adjustment before presentation	10	11														
10	Final testing	11	12														
11	Fifth meeting with supervisor	13	13														
12	Presentation to coordinator	14	14														

CHAPTER 8: ETHICS AND STANDARDS

8.1 Relevant Standards Adopted, Testing Procedures

i. Relevant standard adopted, testing procedures

To become a good engineer, the engineer must follow all the ethics and standards which have been set. The most important ethics is integrity and honesty. An engineer must practice the highest standards of integrity and honesty throughout the project. An engineer must be honest in all aspects especially in financial issues. Every cent that is being used in a project must be included in the financial report. This is must so that there will be no unwanted incidents happen to the project. If the engineers do not practice honesty and integrity, they can be penalized by Board of Engineers Malaysia (BEM) under the Engineers Act 1967. In Section 15(1) from the Engineers Act 1967, it is stated that The Disciplinary Committee (BEM for Malaysia) can take action if any engineers violate the law in the Engineers Act 1967 and one of the examples of the law violation including fraud and dishonesty. There are some actions that might be taken to whom violate the law. For example, the engineers will face cancellation of registration as an engineer under BEM and he/she cannot do any works related to engineering. Next, the engineers must follow the International System of Units (SI) for uniformity. There will be a lot of issues that will arise if the engineers do not follow the SI units. The problem will arise when the execution process s especially to the technicians (in industry) as they are the ones who are going to make the design become real.

Next, for the testing procedures. We ran our system for 3 days (6th June 2022 – 8th June 2022) The testing part is divided into a few parts which are in designing, electronic system and actual test. Testing is very crucial procedure to do before Installing those components such as sensors and main structure materials in order to avoid failure during actual implementation of the system and to save cost.

For designing part, we used the Computer Aided Design (CAD) software which is SolidWorks 2022. After completing the design, we analyzed the design we made in the software by using some special features of the software and setting up some parameters according to what we are going to implement in the system. The design is tested its strength using von mises analysis and the flow of the water inside the pipes by using the flow simulation of fluid. The SolidWorks has the features to complete all the simulation needed.

For the electronic system testing, we used the Arduino IDE software to test all the electronics parts which are the sensors and hardware. To test the sensors, we wrote some specific coding to enable the Arduino IDE to obtain the data from the sensors that we used one by one by using the text editor for writing code, message area, a text terminal, a toolbar with buttons for common operations and series of menus. Those tools are already available in the Arduino IDE software. The software enables the computer to get the data from all the hardware used in the system.

After finish testing all the electronics parts, we tested the actual components of the system which are the main structure strength, pipes and main compartment leakage and the pumps functionality. For the main structure, we put the soils on the main structure as the soil give significant effect on the load that the main structure. For the pipes, we tested the pipes leakage by flowing the water inside the pipes using the water pump and see whether any leakage presence along the pipes and main compartment is there so that there will be no leakage occurs as this will harm the electronic part of the system. By doing this, we also test the pump functionality concurrently.

8.2 Safety and Health Consideration

Smart farming is important in improving crop quality as well as making the planting process more effective. However, there are some safety and health considerations that we need to take into account to minimize the potential problems that might occur in the system. First, is the data analysis. Powerful data analytics capabilities are at the core of every smart agriculture solution, and it is one thing to collect the data. However, the data will become useless if the user cannot make sense of it. The user needs a tool that can assist in turning the data collected into useful insights. Next, is data security. Working with volumes of data is a requirement of IoT technology in agriculture. More potential security threats, such as data theft and cyber assaults, result because of this. As a result, all smart farming devices and software must be encrypted and safe.

Other than that, data collection frequency is also a safety consideration. One of the key issues provided by smart farming is the safe and timely distribution of a wide variety of data kinds. Aerial, environmental, and field-based sensors, as well as tags on machinery and equipment, must all be sent on time so that farmers may make decisions based on this interconnected data.

Next, is the connectivity of the system. Each linked device should have a sufficient wireless range to interface with the other sensors and transmit data to the central server and reporting panel. The connectivity between IoT facilities should be strong enough to resist inclement weather and ensure that operations are not disrupted. Lastly, hardware maintenance is important as well in order to have a sustainable smart farming system. Field sensors must be able to endure the conditions in which they are deployed. As a result, your smart farming hardware should be long-lasting and simple to maintain.

For health considerations, all the electrical components must be stored away from water or rain as it might cause electrical hazard to the user. Also, periodical maintenance is needed to ensure that all the electrical components, the sensors and the pump are in good function.

CHAPTER 9: SUSTAINABILITY

Agriculture's challenges, such as the need to double food supply, have now elevated agricultural sustainability to the level of assuring food security. There is a need for a resource-efficient global food system that also takes sustainability into account. With rising demands and a greater need for sustainable agriculture, it is becoming increasingly necessary for farmers and other stakeholders to spend more on knowledge and more advanced tools and technologies. Goal 2 of the United Nations Sustainable Development Goals is to eliminate hunger, ensure food security and improved nutrition, and promote sustainable agriculture. Agriculture must be sustainable now more than ever to ensure the attainment of SDG 2 and enough food for all in the future, with scarce natural resources diminishing, inevitable impacts of climate change, and a growing global population.

Before this, we need to know on how smart farming system can help in promoting sustainability. The availability of the real time data is essential for smart farming and sustainable agriculture. Smart farming combines the real time responses and the condition of the crops, thus helping the farmers to make a better decision. Sensors, for examples, assist the farmer in determining when to distribute certain resources in enhancing the ecological and economic outcomes. In this session, we will discuss more how sustainable smart farming systems can contribute to the environment as well as society.

First, the sustainable smart farming contributes to environmental conservation. The environment plays a critical role in meeting our basic necessities for survival. In turn, it is our responsibility to protect the environment so that the future generations do not go without it. Sustainable smart farming contributes to the replenishment of the soil and other natural resources like water and air. By practicing sustainable smart farming, the farmers will reduce their dependency on non-renewable energy, reduce the chemical use and conserve the rare resources. Knowing that the expanding population and demand for food, this replenishment assures that these natural resources will be able to sustain life for future generations.

Next, sustainable smart farming enhance public health safety. Pesticides and fertilizers are not used in sustainable smart farming. As a result, farmers may produce fruits, vegetables, and other products that are safer for consumers, employees, and the communities in which they are grown. Sustainable farmers may safeguard humans from infections, poisons, and other dangerous pollutants by carefully and properly managing livestock waste.

Air pollution and water pollution can be reduced by practising sustainable smart farming. Sustainable agriculture implies that any waste generated by a farm is recycled within the farm's ecology. The waste will not be able to pollute the environment in this manner. By absorbing agricultural residue into the soil, practicing appropriate amounts of tillage, and planting windbreaks, cover crops, or strips of native perennial grasses to prevent dust, sustainable agriculture can enhance air quality.

While for social impact, smart farming has the potential to increase young participation in agriculture. The social impact of new technologies must be taken into account when pursuing the fourth industrial revolution and 'agricultural 4.0.' Sustainable. By practicing this sustainable approach, society will more focus on smart farming in order to create a more sustainable phenomenon among the youngsters.

Workers profit from sustainable agriculture techniques since they are offered a more competitive compensation and incentives. They also operate in humane and equitable working conditions, which include a safe working environment, appropriate food, and living quarters.

We can conclude that by having smart farming system, it can lead to sustainable approach which is beneficial to the society and thus helps in closing the demand gap among the society. Also, the sustainable approaches tend to create a greener environment as it involves less harmful substances and the usage of non-renewable energy.

CHAPTER 10: Project Progress/ Results

10.1 System Features

Table 28: Packed feature inside the system

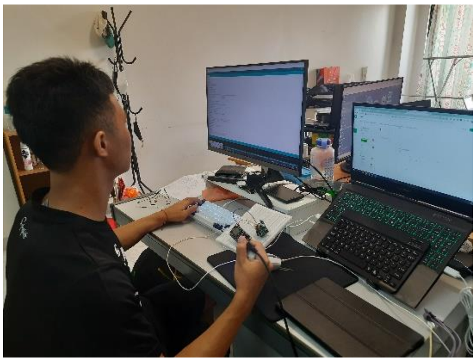
No	Feature	Description
1.	Smart monitoring mobile apps	Blynk mobile apps will be installed on every customer's smartphone so they can get access to the developed user interface. This application will show the soil humidity, fertilizer level and allow control to some features such as switching off the pest control feature at night. This mobile application also will notify the user if there is any rain at the farm/ module.
2.	Carefree and minimal maintenance	For this system, there is only minimal maintenance which is refilling the fertilizer container once a month and replenishing the big water tank when it is out of water.
3.	Efficient water supply	For this feature, water only will be supplied to the soil by using a pump when the sensor detects the soil moisture less than 45%. Hence, the electricity used to pump the water can be minimize and saved up the overall energy usage in the system.
4.	High Frequency Bird/ Insect Sound Repeller	To protect the crops from being damaged by the bird, high frequency bird sound Repeller is used. When the sensor detects there is some motion or obstacle in front of the infrared sensor, the system will

		automatically emit the high frequency buzzer sound to get rid of the bird.
5.	Rain and temperature detection	The system is enhanced by additional feature like rain and temperature detection. Rain and temperature sensor is installed at the system to detect parameter changes and notify the user through the mobile application.

10.2 Project Progress

Table 29: Different phase of the project

<table>
<tr><th>Phase</th><th>Evidence</th><th>Description</th></tr>
<tr><td>Preparation</td><td>
</td><td>Cutting the pipe following the design dimension.
Smoothen the pipe surface using chisel.
Cutting and drilling the Perspex using band saw machine and bench drill machine</td></tr>
</table>

Programming		• Debugging Node Lua v3 ESP8266 to enable Wi-Fi connection and calibrating the sensor for accurate data detection • Design the circuit connection from MCU to sensor and actuator • Synchronize the data and state from Blynk IoT platform to MCU and User Interface
Installation		• Attached the Perspex using silicon glue • Apply water sealant. • Installing electronic components. • Pouring the soil and seeds into the module.

		
Testing		• The sensor is tested its functionality. • We found out several errors occur such as not functioning sensor, pairing device error and broken relay switch. Sensor is replaced with a new one and tested again. • Other than that, we also test the water sealant of the crop module. We found out that, there are some parts of the crop module is leaking. • Extra adhesive is added to protect the electric component at the below section.

10.3 Project Result

The result shown below is testing done on the system days from 6th June 2022 until 8th June 2022 to test its functionality and waterproofness. The entire system was run after all the peat moss and crops were put inside the container. The result is monitored via the User Interface developed using Blynk (an IoT Development Platform) that shows us the real time data and result. The Interface is available in both Web and Mobile mode.

10.3.1 User Interface

Figure 57:Blynk User Interface (Web Dashboard)

Figure 58: Blynk User Interface (Mobile Dashboard)

10.3.2 Soil Moisture Result

From the interface, it showed us the soil moisture and soil temperature value, rain sensor indication, fertilizer level indication. Soil moisture and soil temperature is also available in chart form ranging from hours to days, weeks and months.

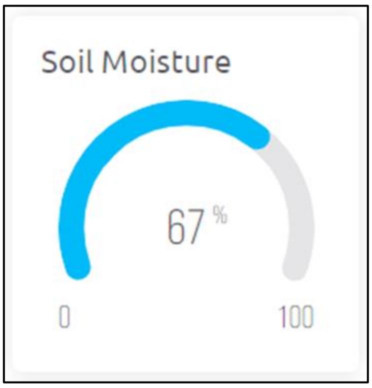


Figure 59: Soil Moisture Indicator

Figure 60: Soil Moisture Sensor Module

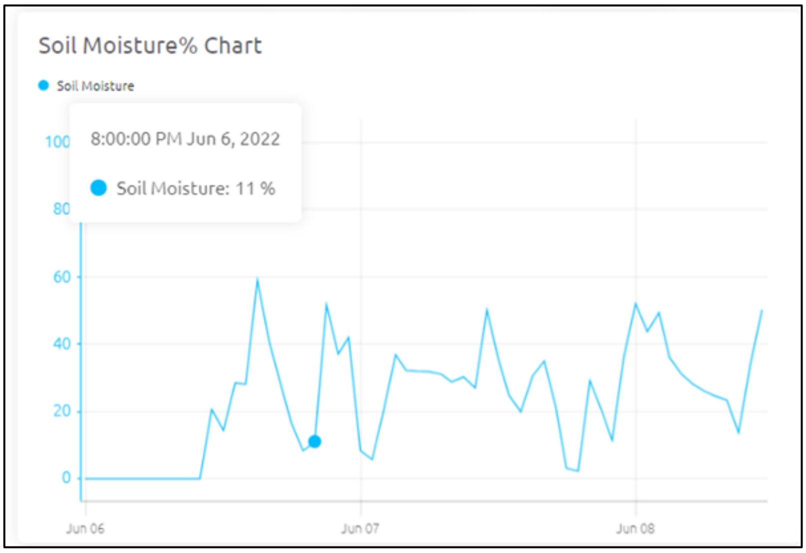


Figure 61: Soil Moisture Chart

From the Figure 46, the platform will show the real-time soil moisture. The program is coded to show that as the soil moisture is below 45%, the water pump will pump water from the water tank to the crops. In application, the soil moisture sensor module is placed inside the soil to detect the soil moisture percentage. The soil moisture chart will show the percentage of soil moisture for every 1 hour. From soil moisture chart above, it shows the trend of soil moisture during the testing period. We can see that the graph is decreasing with time but increase back once the soil moisture percentage is lower than 45% threshold value. Overall, it will form a fluctuating line from time to time. This graph declining trend is due to the water moisture inside the soil is evaporated to the environment while the water is pumped to the crops, the graph goes upward back.

10.3.3 Soil Temperature Result

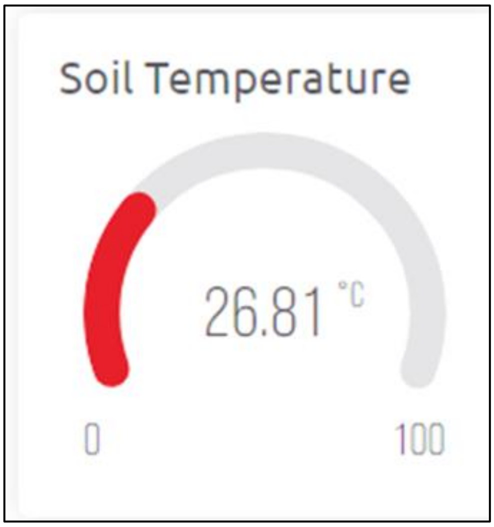


Figure 62:Soil Moisture Indicator

Figure 63: Waterproof Temperature Sensor

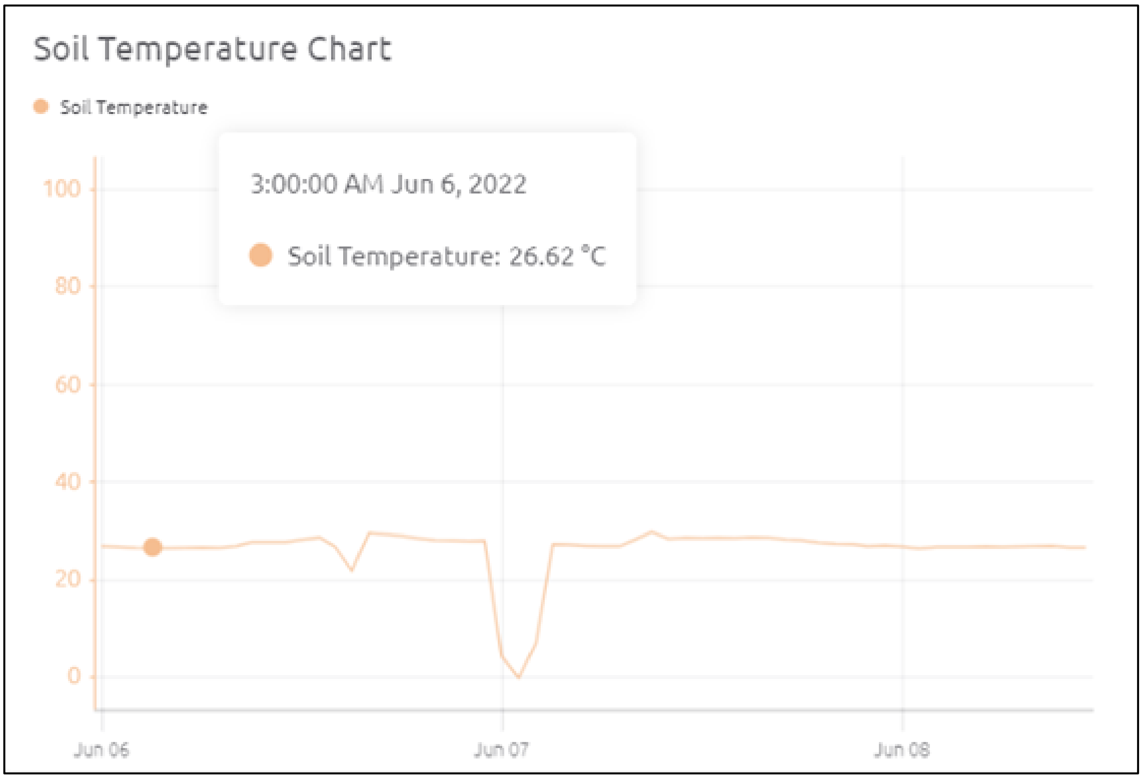


Figure 64: Soil Temperature Chart

From Figure 49, the real-time soil temperature value is plotted against day. The graph showed a constant trend for soil temperature value in the testing period which means the waterproof temperature sensor has high consistency. This is also due to the prototype built is placed indoor which do not have much in-room temperature changes. The steep drop to

0.00 °C during early start of 7th June 2022 is due to disturbance on the system during testing phase. It might be the sudden restart/ reset of the MCU, short duration of Wi-Fi connection lost, sudden high voltage supply shock on the system circuit and many mores. In short, the average temperature throughout the testing period is 26.00 °C.

10.3.4 Pest Control via Infrared Sensor and Buzzer

Figure 65: Infrared Sensor

Figure 66: Infrared Sensor with Obstacle in front emitter and receiver

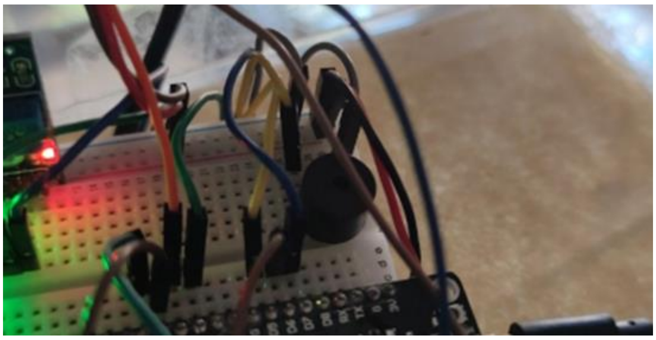


Figure 67: Buzzer

Figure 68: Infrared Button Switched Off in Blynk

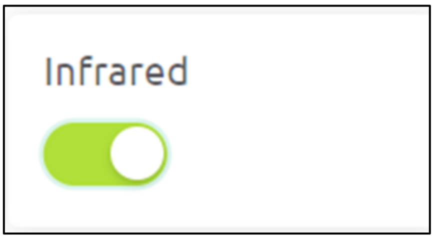


Figure 69: Infrared Button Switched On in Blynk

The infrared sensor emits waves through the emitter and the receiver will sense the waves back if there is any object placed in front of it. This obstacle is illustrated as bird/ insects in our application. If there is any object placed in front of it and the infrared button in Blynk is switched on, then, the buzzer will emit a high-frequency sound to get rid of any pests such as birds that may stifle the growth of the crops. An Infrared Button is developed in the user interface so the user could choose to turn it off if they deemed the sound of the buzzer is too noisy during certain times such as nighttime.

10.3.5 Rain Sensor Module

Figure 70: Rain Sensor

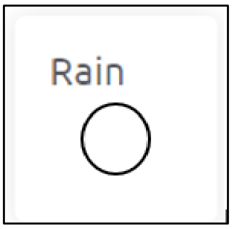


Figure 71: Rain Indicator in Blynk as Not Raining

Figure 72: Rain Indicator in Blynk as Raining

The rain sensor is placed at a high location on top of the system. The sensor panel strips detect if there is any water droplets on it, the LED indicator in Blynk will light up to indicate that there is rain and turned off back once the rain droplets dried up. At the same time, a notification will be sent to User Signed in Mobile Apps as figure 58.

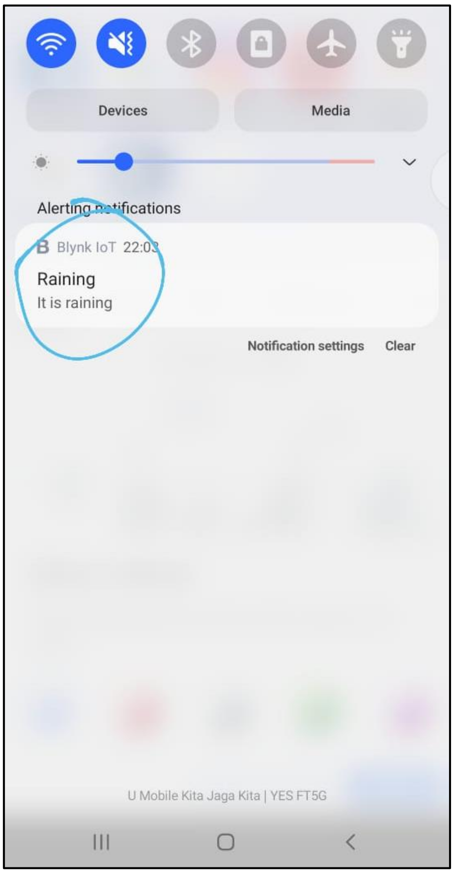


Figure 73: Raining Notification in Mobile Apps

10.3.6 Fertilizer Level Module

Figure 74: Moisture Sensor Module

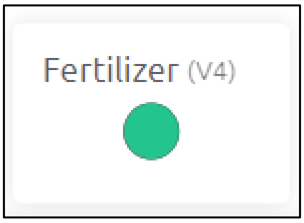


Figure 75: Fertilizer Level Indicator as Still Enough in Blynk

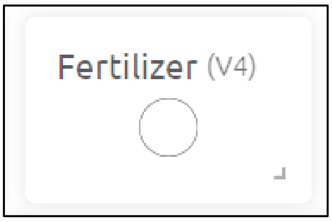


Figure 76: Fertilizer Level Indicator as Depleted Enough in Blynk

The moisture sensor module is used as replacement of water level sensor through some coding and calibration. It is placed in the fertilizer tank to detect whether there is whether the fertilizer solution is lower than the desired threshold level. If fertilizer solution level is still high, then the fertilizer indicator inside the Blynk will light up as green. However, once the green LED indicator lights off, the user knows that he/she needs to refill the finished fertilizer. Also, a notification will be sent to User Signed in Mobile Apps as figure 62.

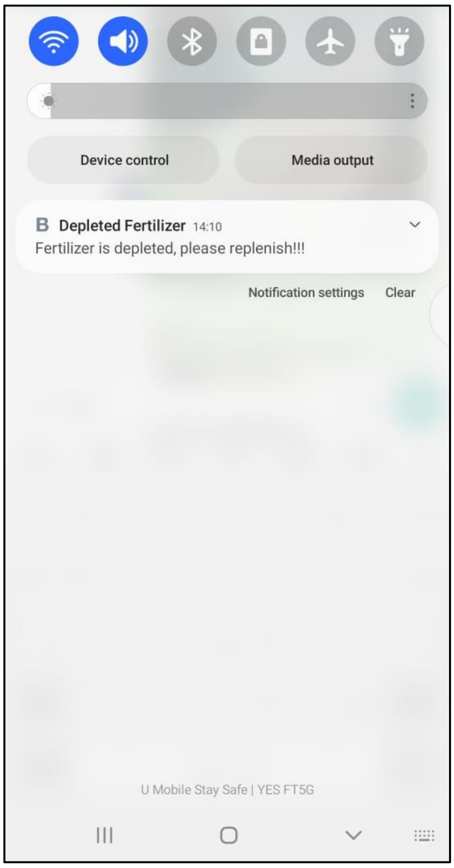


Figure 77: Fertilizer Depleted Notification in Mobile Apps

CHAPTER 11: CONCLUSIONS

The Carefree Smart Farming System aims to help people who live in urban areas to plant crops efficiently by applying automated systems and IoT. Our smart farming system is more suitable for high-rise residential residents and small urban farmers as it is affordable and less time-consuming when it comes to crop growth monitoring and nutrient supply. Several subsystems such as the microcontroller system for sensor control and interface, interconnection of the cloud services along with the data analytics platform through Wi-Fi module. A few sensors such as soil moisture sensor, soil temperature sensor, fertilizer sensor and rain sensor are used in our system. The relay will switch on the pump and pull up the water module when the soil moisture of the peat moss is detected lower than 45%. Also, the user will be notified when there is rain through the mobile application, Blynk. In order to protect the crops from birds, the high-frequency bird sound repeller will emit the buzzer when the birds come close to the crops. All the conditions can be monitored through the Blynk application. In short, we consider our project a success as the objectives are both met.

There are many challenges in this project. First, is the unstable internet connectivity. The system must have stable internet connectivity so that we can proceed with fast transmission speeds. Next, is the design of our system. Our team has changed some designs for our system and after several trials and errors, we came up with the final design which is the most suitable one that meets our goals. Also, there are some future works that can be done for the improvement of our product. First, the mobility of the product can be improved as the product are quite difficult to move from place to place. By doing so, the product can be moved freely without experiencing any component failure. Next, the user can customize the type of electrical components used based on their needs and the type of crops. By doing so, the system can work at its optimum level in a different environment without causing failure.

By having our product, the user can reduce the time and effort needed as a better communication path for the transfer of important data between multiple nodes can be achieved with the help of IoT, wireless sensors and network communication. The users can improve their skill and crop output by using this system which has a wide range of applications. From our testing and results, we discovered that the technology and materials we employed to produce our prototype enabled us to create a cost-effective, efficient, and accurate product for farmers which was also cost-effective and simple to install for farmers. As a result, we can infer that this prototype will undoubtedly assist small-scale farmers in efficiently monitoring their crops using a user-friendly app and other alarm mechanisms.

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