MEB2063 ENGINEERING TEAM PROJECT
PROJECT REPORT
AQUAPONIC
GROUP 66
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First and foremost, Alhamdulillah, praise to Allah (S.W.T), with His will, we finally completed this project, drain cleaning machine. We give God, the Almighty, all the glory for His blessings that enabled our group's Engineering Team project work to successfully complete the assigned mission.

We would like to extend our sincere gratitude to Mr. Mohd Syaifuddin Bin Mohd, the leader of our team, for approving the completion of our project and for his helpful guidance during this research. We have been inspired by his enthusiasm, vision, genuineness, and motivation. He has imparted knowledge on how to conduct research and effectively explain the results of that research. Being able to work and study under his direction was a huge honor and privilege. We are incredibly appreciative of what he has supported and provided us with. We also appreciate his friendliness, understanding, and wonderful sense of humor.

We are incredibly appreciative of our parents' love, prayers, care, and sacrifices in order to raise us and get us ready for the future. We appreciate our parents' aid in guiding us through this project, helping us to buy the necessary supplies, and guiding us in many other ways.

We would like to express our gratitude to each individual member of our group for their support, especially Mohd Arief Bin Engah, Mariah Nur Adlina binti Mohamad Hafizan, Munna Farra Sofea binti Mohamad Nas, Prasad A/L Karuppayah, Rizan bin Rudin, and Yip Yan Leong. We appreciate the management of the lab's ETP project team for their ongoing assistance in carrying out and finishing this task. We could never finish our prototype without them. They provided us with constant direction and assistance in locating and using the materials, and we were able to successfully finish our prototype with their aid.

Finally, we would like to express our gratitude to everyone who helped us, directly or indirectly, to accomplish the project.

EXECUTIVE SUMMARY

Through the agriculture in Malaysia has become a cornerstone and hydroponic culture term coined by the Dr Richard which is an organisation among HAVVA vitapolik, SIRIM University. It is projected to transport abroad in countries like Singapore, Indonesia, Brunei. This is becoming increasingly important as governments around the world commit to major sectoral and national development plans, as well as regional and global development agendas. Additionally, the COVID-19 pandemic, while hampering national capacities to collect data, and emphasized the pressing the need for data and statistics to enable timely responses and monitor trends. The income of each project could be liable for everyday operations with route from an on-web website online task manager, therefore selling owner self-sufficiency and assuaging reliance on outside investment reassess for the authorities for man or woman.

Consequently, vegetables must be shipped from the centre of the country for most of the year, especially during the winter. During these months, the price of vegetables rises significantly and the quality drops significantly. The continued growth of the tourism industry in the region has made HAVVA vitapolik an attractive market for local fish and vegetables. Restaurants serving this growing tourism industry need high quality produce all year round. In addition, social and environmental benefits make the product attractive to tourists who are concerned more about their impact on the community.

The business revenue will continue until the source of income justifies the establishment. It aims to prove two imported since the region's arid climate limits agricultural viability. In addition, it is difficult to obtain fresh organic produce in the Peninsular Malaysia . As mentioned above, most agricultural products are imported because the dry climate of the region limits the practicability of agriculture. In addition, the long history of unregulated fish production raises scepticism about the quality of fish in the region. Not only can SOS Aquaponics manufacture such products locally, but they can also better control the quality of these products and build relationships of trust

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CHAPTER 1: INTRODUCTION

1.1 Project Background

Aquaponic is a type of agriculture that combine growing fish (aquaculture) and plants without soil (hydroponics) in a shared environment. The world is facing number of serious problems of which population rise, climate change, soil degradation, water scarcity and food security are among the most important. Nowadays, most household had developed install aquaponics systems. Our ecosystem with aquaponic is essential for every plant to grow healthy, if this put it on outside, it can easily catch by budworm like caterpillars that what even to end up being convenient to grow at easy-to-grow without the need for pesticides or synthetic fertilizers. For example, it can be used as a sustainably food supply which is great raising the food crisis in for a family to feed a village or generate profit in this pandemic year.

Instead, this project will start building drain off in a closed loop system consist with a fish tank, grow bed with gravel and shale, 3-in-1 wholesale PH meter, air pump and water purifier. The cost of building and supporting our aquaponics system are not expensive to build. We also serve as surface for bacteria to thrive inside the grow bed and acts as a filter for the solid waste that expelled out of the fish tank and into the grow bed like soil, it protects and ensures that plant root is established in the right position where the plants are grown in floating rafts and PVC pipes. The same concept applies for our project use a grow media for aquaponic are ½ to ¾ in size that might be too small to clog the system. While if too large, media also cause impact on air gaps that may affect plant growth. The goal to contribute to the global issue to ocean and marine life. Waste pollution is an impact of the waste build-up of solid objects like plastic bags, nets, cans in which harmful to wildlife and human habitat. Waste is polluting the environment. This can affect severely on land. As in 2012, it was estimated that there were 2.2 billion tonnes of waste product in the world ocean, with that we expect to rise to 2.5 billion tonnes by 2025. Every year, between 2.1 to 5.5 billion tonnes of litter enter ocean from coastal areas. This is due to waste increase day by day and much as it was smaller than 5 millimetres. Some of marine life including fish, turtle, whale, and dolphin, was died because of stranding or ingest with plastic debris in their body, they become not enough nutrition and unable to detangle themselves, so they tried to prey and lead them to suffocate and drown.

Aquaponic are inspired by the designing system because of current aquaponic system project. This is commercial regular base from Malaysia with a simple and eco-friendly project to contribute to cleaner and more sustainable ports. The goals National Policy on the Environment are also developed with Sustainable Development Goal (SDG) to focus on dispose waste of the global consensus. With SDG, has being succeeded with the marine had achieved by goal 6 and 11 which is water sanitation, sustainable cities, and society. However, this system unlike artificial ponds, which use every system with a dedicated backup supply, especially you are in a rural area without blackout aid power supply that are easy to build.

1.3 Problem Statement

Rapid urbanization and population growth in the modern era have resulted in a scarcity of agricultural lands. The agricultural land destroyed the building to construct a new renovated building and residential area. Aquaculture's environmental impacts include integrated aquaculture. ASEAN Declaration on Environmental Sustainability which, declared to promote conservation and sustainable management of key ecosystems, including forests, coastal and marine habitats and to increase the cumulative forest cover in the 2 ASEAN region and to address the country's climate solution issue. According to reports, Malaysia Environment Law reserved and repaired 390,000 sites in 2019, while 65,00 sites were reported with investigations underway. However, in Malaysia, we still lack in achieving zero soil and this result in increasing the number of death due to the safety hazard on the visible road pothole. Also, Aquaponic operators are the Strategy on preventing and recycling the waste and the 7th of National Policy on the Environmental (NPE) under the MI Environment Policy. Modern soil-based agriculture uses approximately 70% of all water produced in Malaysia, most of which are evaporated. In contrast, the closed system of aquaponic is losing a trillion of gallons of water every year, industrial agricultural techniques produce runoff of soil that hold excess fertilizers, herbicides, pesticides, and other chemicals that pollute the lake and river, even into our groundwater. As source of unpolluted water slightly dry up, this causes the excess use of resources that has become unsustainable.

In this report, we are showing our product is like smart vertical aquaponic system. It is made the breeding of fish in tank under the pipe. With the key part is to make our concept to the circulation of the media acts as a filtration or disinfected as possible as enough for plant to capture nutrient. Our goal is to want to choose and pick up which varies size according to the tank we want to use it the device itself. The tank must be ensured that can be reduce work and effort need to clean up the fish and settling tank. After paring is done, it will make the clean-up process less of a mess but enjoying process. The system also should be made smaller than the usual and able to migrate to confined spaces.

1.4 Project Objectives

The main goal of this project to suggest some problem for the agriculture and plantation in achieving use of zero soil and saving water. It is aiming to use sustain and conserve the ocean and plant for aquaponics development. This can achieve as the following aims,

1. To name the definition and principles of permaculture full cycle ecosystem and aquaponic machine past building architecture
2. To discover the potentials of permaculture and aquaponics system that can create a green living environment model and accommodate food shortage.
3. To name different integration method that can make the process of growing plant condition in fully self-powered, simple, and quicker.

CHAPTER 2: DESIGN PLANNING

2.1 Literature Review

No	Authors	Topics	Findings
1	Ronald D. Zweig	An Integrated Fish Culture Hydroponic Vegetable Production System	• The core strategy of integrated hydroponic system is to maximize efficiency of the system's biological components, maximizing economic performance. • Water is an excellent medium to exploit the solar energy for greenhouse systems, as it can function as a passive solar collector and heat storer. Other than that, is also used for fish, culture, and the resultant fertility from fish wastes are used, for hydroponic plant production, increasing the efficiency of the system further. The fertile fish wastes in the pond water are thus directly accessible to the plant roots. • In some of the hydroponic system, the closed cell Styrofoam floating on the surface of the ponds help to supply rigidity to the plants, insulate the water from heat loss, and reflects added light to the plant's leaves. • The plant (usually lettuce) can be at the marketable sizes, usually around after 6 weeks from seeding which makes the cycle of harvesting faster. T • The plant roots in a hydroponic system are a habitat for zooplankton, nematodes, and midge larvae which consume the detritus on the roots. With proper aeration (induced with water cycles), these organisms are made available to the fish as recycled feeds when they leave the root masses. Thus, the harmonious of the system is highly likely as the plant and fishes mutually supply each other needs. • Maintaining the proportioning of these two respective components is crucial as it can put the system at their best operating environment.
2	M.N. Mamatha and S.N. Namratha,	Design & Implementation of Indoor Farming using	• Aquaponics is defined as the system of aquaculture in which the waste given out by the fish acts as the nutrition for plants grown hydroponically, this purifies the water in turn. It is an ecosystem where in

		Automated Aquaponics System	plants and fish lives in a symbiotic relationship. • Aquaponics system constantly watches and analyses the conditions of fish and plants, takes automated restorative actions to balance the aberrations based on data and qualitatively defer from the collected data to improve the conditions for operations, risk reduction and manual intervention for the setup of the fish. • Real time overview of the different parameters collected from the system like temperature, intensity of light, and amount of food fed etc., of the designed system is given by the solution. • The system architecture for a controlled aquaponics set-up involves multiple sensors, instruments and devices checking and controlling the parameters of the system. • It is an added advantage to support the efficacy of the hydroponic by monitoring the water quality, monitoring pH, maintaining the proper temperature of the water for fish survival, maintaining the light intensity inside the aquarium which in turn results into a better aquaponics system.
3	(Masabni et al., 2020)	Excellent Species for Aquaponics	• Tilapias are the most extensively utilized freshwater fish in commercial aquaculture and aquaponics. • It is a simple fish to raise on a small to large scale and are excellent tank adapters and high stocking densities (up to ¾ pound per gallon at high aeration rates.) • It has a high rates in terms of production features and is highly desirable in an aquaponic system. • Besides, when conditions are kept to best growth, tilapia can be harvested in 6 to 8 months, with the possibility for two fish harvests each year. • It lives well on a low-protein diet of 26 to 32 percent protein and 4 to 6 percent lipid when compared to other fish species. In tanks, the feed conversion rate is remarkably high, requiring just 1.3 to 1.8 pounds of feed per pound of fish weight gain.

<table>
<tr><td></td><td></td><td></td><td>Next, it is resistant to many infections and parasites, therefore they can tolerate poor or marginal water quality. Diseases in tilapia are also rare. They can survive for brief periods of time in water with a pH range of 5 to 10, high water temperatures, low (DO), and high ammonia.</td></tr>
<tr><td>4</td><td>The Johnsons</td><td>The Top 5 Plants to Grow in Aquaponics</td><td>In an aquaponic garden, growing spinach is simple and rewarding. They do not require much to create. Every day, though, 10-12 hours of sunlight are needed. These leafy green plants can be harvested in 30 to 45 days, and the leaves should be taken off in little intervals because they spoil quickly.
Best conditions for spinach aquaponic growth
Spinach will grow best when all the requirements mentioned below are met:
Water temperature: between 45° and 75°F
pH: between 6.0-7.0
Spacing between two plants: 4-5 inches apart
Nutrient requirement: low
Aquaponics system: NFT or Raft system
Best spinach variety for an aquaponic garden: water spinach</td></tr>
<tr><td>6</td><td>Aquaponics Supplies - a Shopping List – How to Aquaponic, 2015</td><td>Materials required to assemble an efficient aquaponic system</td><td>To get started with an aquaponics system, you will need certain criteria. Naturally, some arrangements need fewer materials and supplies than others.
One of the most important items is the grown bed. This is where the plants will be found. Grow beds can be constructed out of anything that can hold water and is sturdy enough to hold the growing material. For example, even a hardware store bought plastic tub can be used as a grow bed for a scaled down aquaponic system.
The next important material needed is the Growing medium. The growing medium used to keep the plants in place. It also serves as a location for the bacteria that converts ammonia to nitrates.
There are three types of growing media which are often used which are lava rocks, river rocks, and clay pebbles. All these</td></tr>
</table>

			growing media have their advantages and disadvantages, they must be considered to fit well in the Grow bed. • The next item is and immersible water pump, the head height of the pump needs to be considered to ensure water in the fish tank is cycled once every hour.
7	Nigam, S. & Balcom, P (2016)	Project OASIS: Optimizing aquaponic Systems to Improve Sustainability	• Aquaponic is the fusion of aquaculture (growing fish) and hydroponics (growing plants without soil) that is more effective than either independent process. • It is a symbiotic relationship as the fish supply nutrients for the plants to grow while the plant and bacteria is used to clean the water for the fish to survive • Water is the most valuable source about 70% of the world's freshwater is already being used up for agriculture • Aquaponic system supply inorganic medium where the plants can thrive back due to the inadequacy of competition. • There is no opportunity for weeds to develop because only organic matter is introduced into the system. • Aquaponic produce an entirely organic matter that can be sold in a higher price. • The fish will also supply a protein source which is beneficial during the food crisis • Aquaponic are less labor intensive and are more conventional in -farming as well as it is ideal for drought-prone and water scarce regions. • It is resistant to weather changes • Tilapia is the most common grown fish because it is hardy, tasty ad quick growing but Pangasius can grow even faster and are able to survive in a more extreme condition. • There are 3 main types of aquaponics: 1. Raft 2. Nutrient Film Technique (NFT) 3. Media-filled Beds • Raft systems though are limited to only certain types of vegetables like leafy vegetables. • Meanwhile, media beds can support fruiting plants like peppers and tomatoes.

8	Turkmen, G. & Guner, Y.	Aquaponic (integrating Fish and Plant Culture) Systems	• The aquaponic systems is designed closely that of recirculation system un general with an additional of hydroponic component and possible elimination of a separate biofilter and devices like foam fractionators to remove fine a dissolved soil. • The effluent from the fish tanks is treated first to reduce the organic matter in the form of suspended solids. • Then the culture water is treated to remove the ammonia and nitrate in a biofilter • The water will flow into the hydroponic unit where there will be some dissolved nutrients to be taken up by the plants while the additional ammonia and nitrate are removed due to the growing of bacteria on the sides of the tank and the underside of the rearing tank. • Biofilter and hydroponics part can be combined by using the plant support media like gravel or any growing medium. • Fishes like catfish, koi carp, common carp, Murray cod, largemouth bass, crappies, trout, sturgeon can be used for the aquaponic system, but the most common type of fish is Tilapia. • Though, ONE species that is found to be poorly performed for the aquaponic system is called the hybrid striped bass as they were unable to tolerate elevated level of potassium which is often supplemented to promote plant growth. • The largest biomass of fish system and support without restricting the fish growth are called as critical standing crop • There are a few factors in sizing the hydroponic component which are, sequentia rearing, stock splitting and multiple rearing units.There are a few factors in sizing the hydroponic part which are, sequential rearing, stock splitting and multiple rearing units. • Most of the faecal waste fish can be removed from the waste stream before enters the hydroponic tank by using reciprocating pea gravel filter which will spread the solid evenly over the entire bed system.

			• This is however un-stabilized solid which are solid that has not undergone microbial decomposition should not be allowed to accumulate at the bottom of the tank as it will form anaerobic zones. • Suspended solids however need to be removed as an accumulation in the plant roots can create anaerobic zones that will prevent nutrient uptake by active transport. • Though some solid accumulation can be beneficial as some solid are decomposed by microorganisms, inorganic nutrients that are essential for plant growth will be released to water which is called a process called mineralization. • Mineralization supplies adequate nutrients to the plant root. • Another beneficial of solid accumulation is that microorganism that decomposes them are antigenic to the pathogens in the plant root and could help keep healthy root growth • Usually, fiberglass are the most suitable construction materials for rearing tanks, sums, and filter tanks as it is sturdy, durable, non-toxic, movable, and easy to plumb. Another material suitable for tanks are polyethylene tanks as it is popular material to rear fish and gravel hydroponics because of their low-cost materials. • For NFT troughs, an extruded polyethylene specifically designed for hydroponics are useful to prevent the pudding and water stagnation that can leads to death of the roots and are mostly preferable as it can makeshift structures like PVC pipes. • Another suitable troughs are plastic troughs which are available for floating hydroponic subsystems mainly, though they are very expensive. a good alternative for this subject is a 20-mil polyethylene liners, placed inside the concrete blocks or side-walls. They are easy to be installed, inexpensive and durable with an expected life of 12 to 15 years.

2.2 Design Thinking Tools & Analysis

An online survey was conducted to pursue the public's overview and opinions on this subject matter. A Microsoft form consists of a total of 17 questions including the demographic was released in an approachable manner to the social media and messaging platforms like WhatsApp, Telegram, and Instagram. Since the platforms offers opportunities to obtain public's insights, 70 responses were achieved successfully to be analyzed.

The simplified questions in the Microsoft forms were listed below:

1. Gender
2. Age Range
3. Occupation
4. Residential Area
5. Residential Type
6. Other residential type
7. Combined Family Income
8. Understanding on Aquaponic System
9. Experience in rearing fish and farming vegetables
10. Consideration on those activities due to food crisis
11. Preference of vegetables
12. Other preferred vegetables type
13. Preference of fish
14. Other preferred fish type
15. Preferred Expenditure on the aquaponic system
16. Additional features for the system
17. Other additional feature of the system than listed

2.2.1 Results of Survey

1. Gender : (0 point)

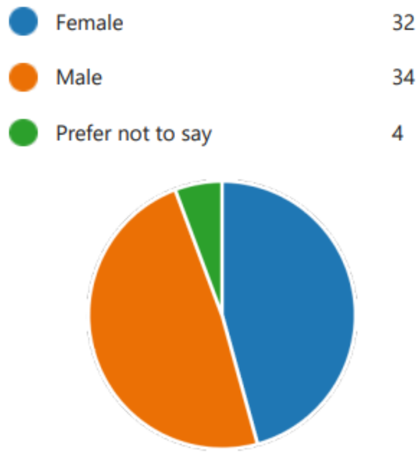
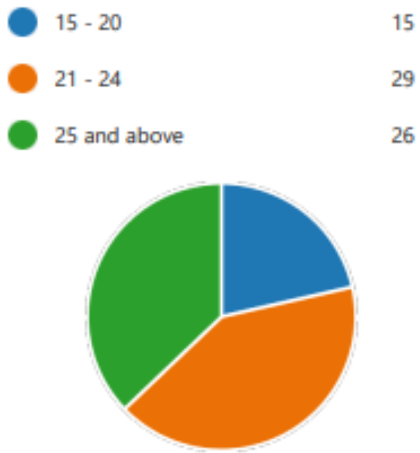


Figure 2.1: Pie chart on the gender of the respondents

2. Age Range : (0 point)



3. Occupation : (0 point)

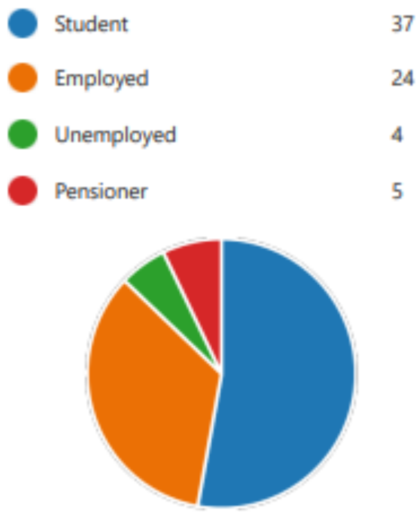


Figure 2.2: Pie chart on the age range and occupation of the respondents

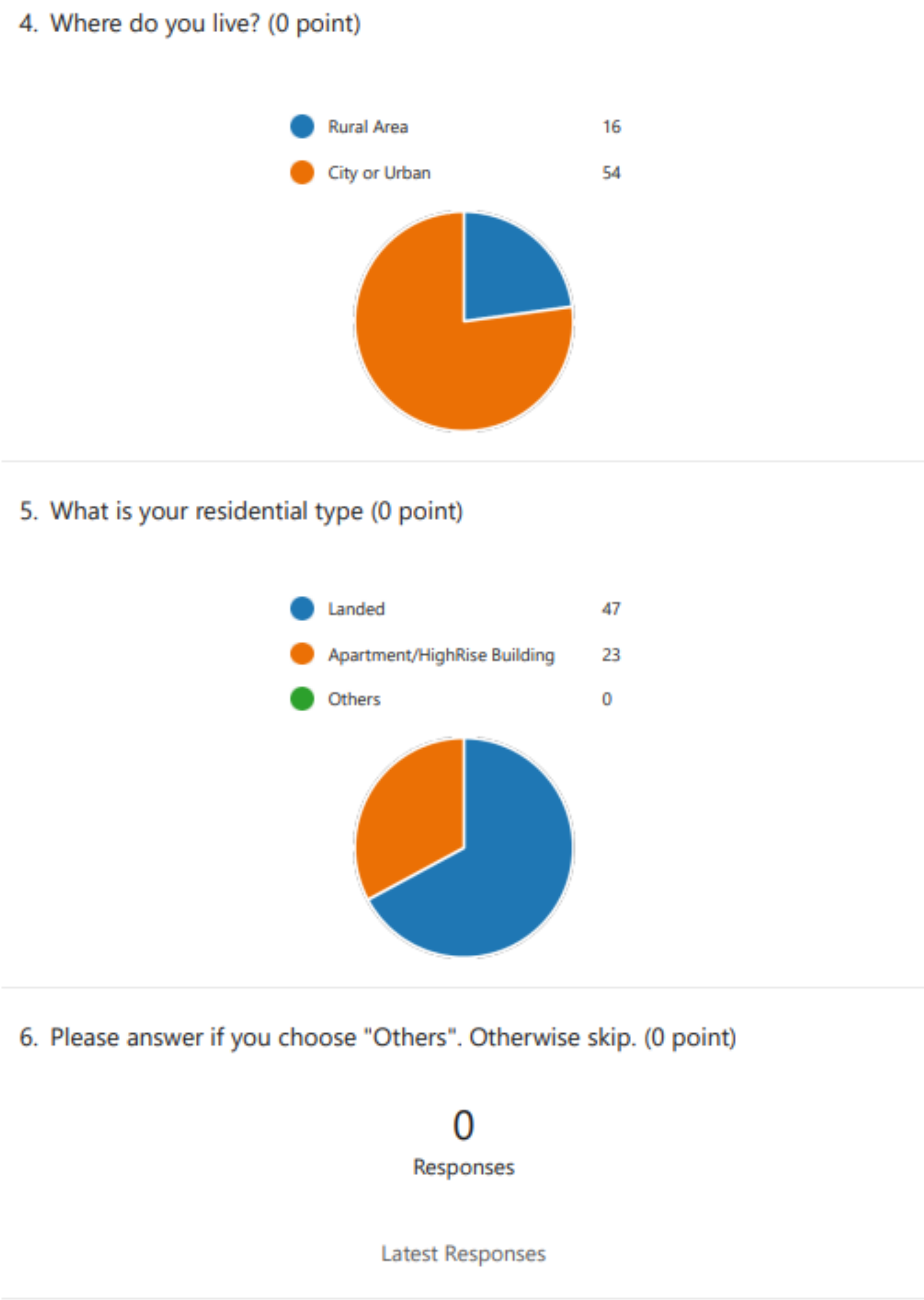
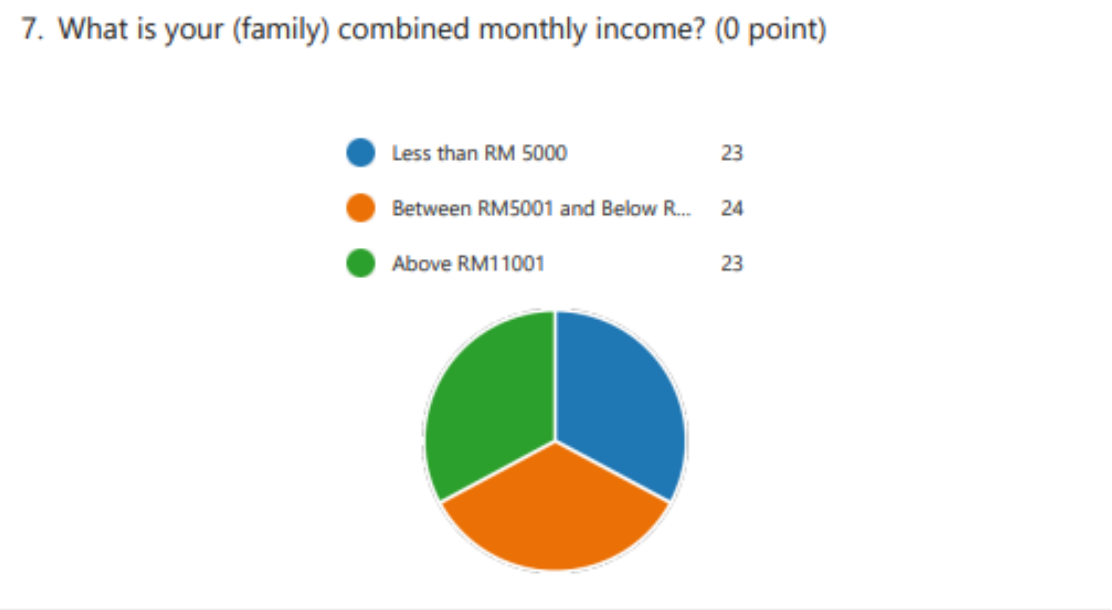


Figure 2.3: Pie charts on the location and residential type of the respondents



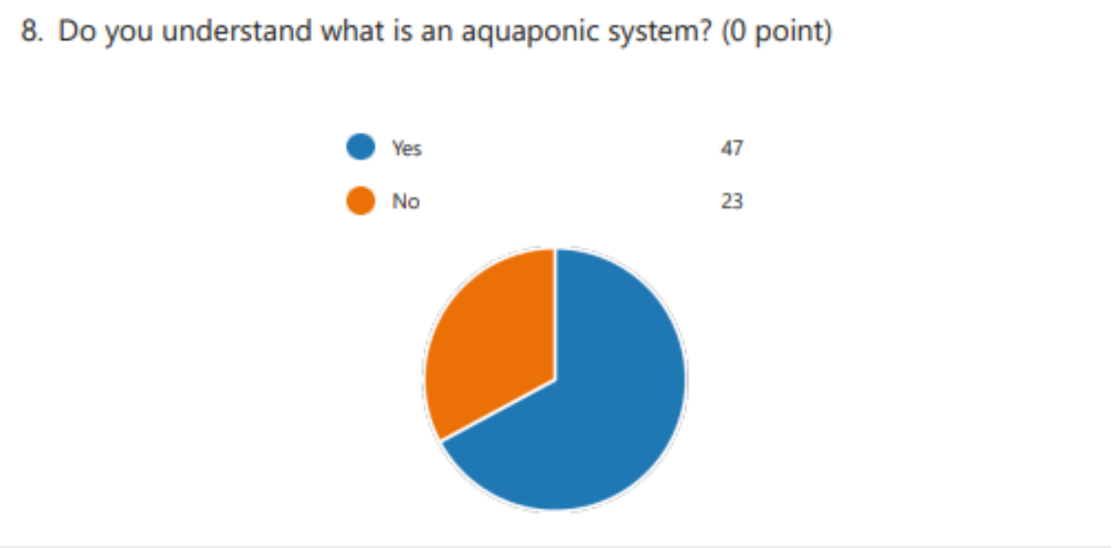
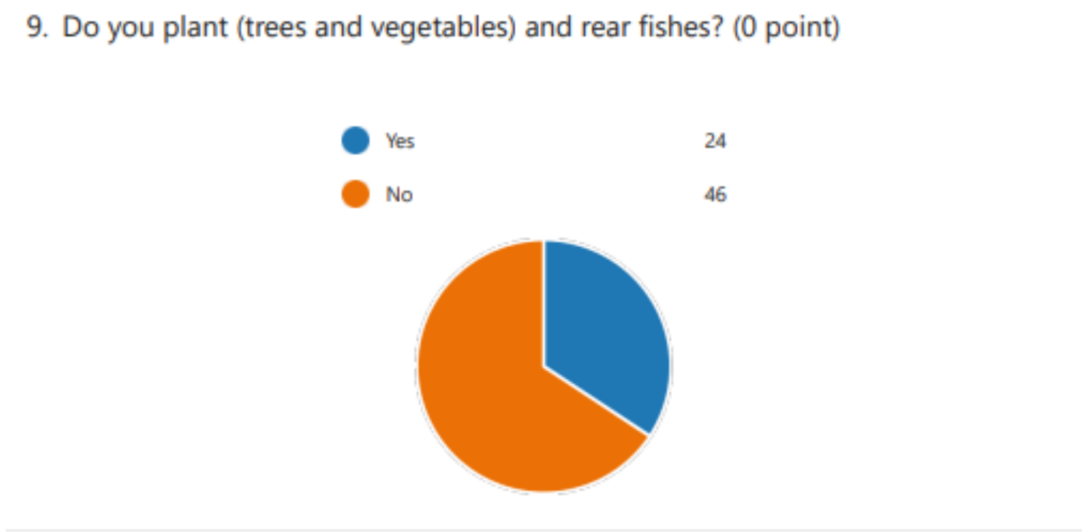


Figure 2.4:Pie chart on respondent's family monthly income and information on aquaponic system



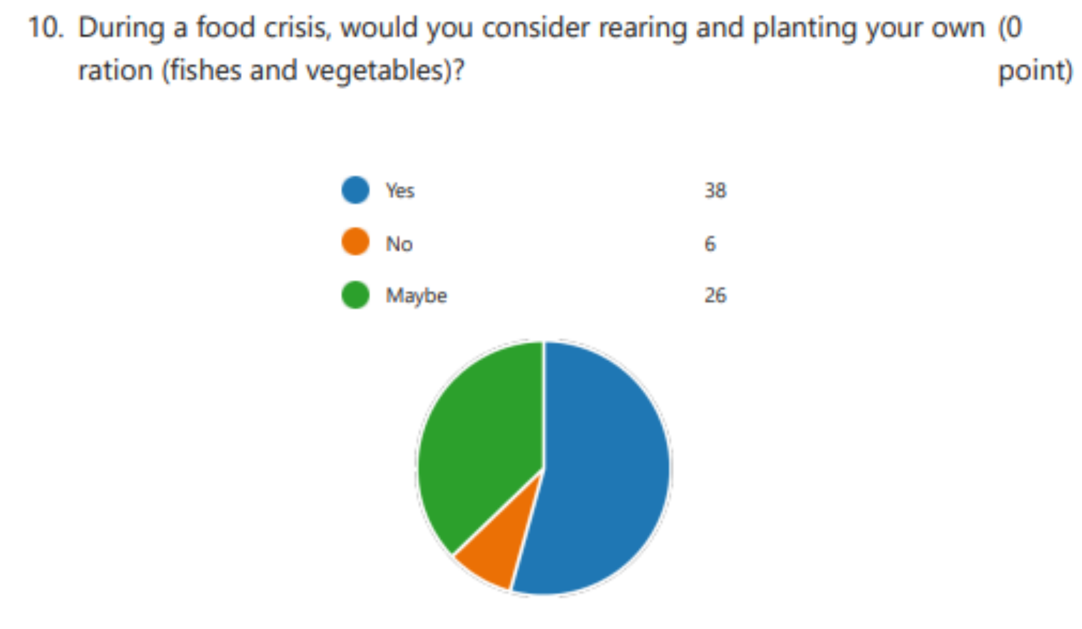


Figure 2.5: Pie chart on respondent's experience in planting and rearing fish as well as their consideration in planting and rearing fish during food crisis.

11. If you choose to do aquaponic, what is your preferable vegetables? (0 point)
Select "Others" if you want to do 2 or more. Eg: Pak Choi + Cabbage

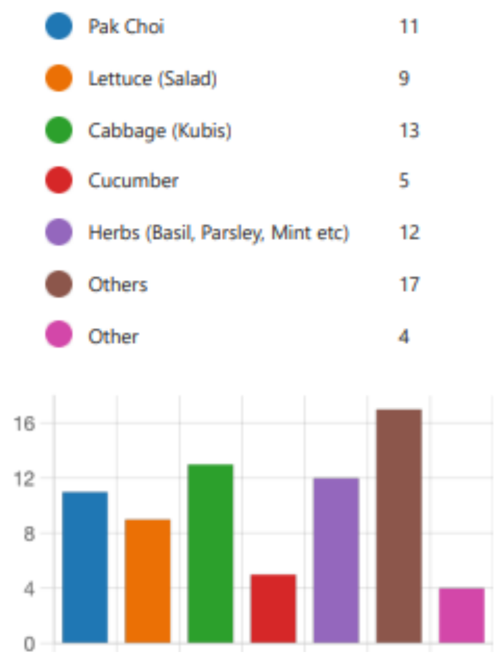


Figure 2.6: Bar Chart on vegetable preference of respondents

12. Please answer if you choose "Others". Otherwise skip. (0 point)

18

Responses

Latest Responses

"Pak choi lettuce"

"Herbs n Salad"

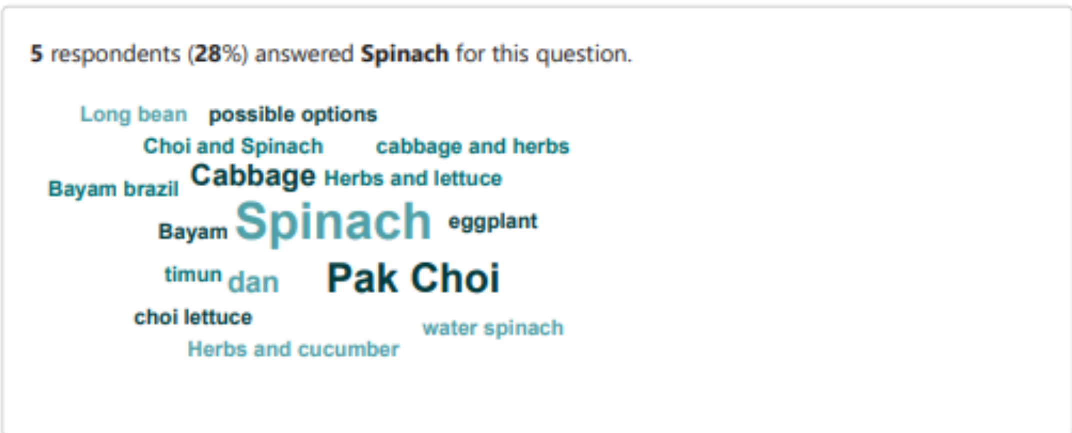


Figure 2.7: List of other vegetable preferance of respondents

13. If you choose to do aquaponic, what is your preferable (edible) fishes? (0 point)
Select "Others" if you want to do 2 or more. Eg: Keli + Tilapia

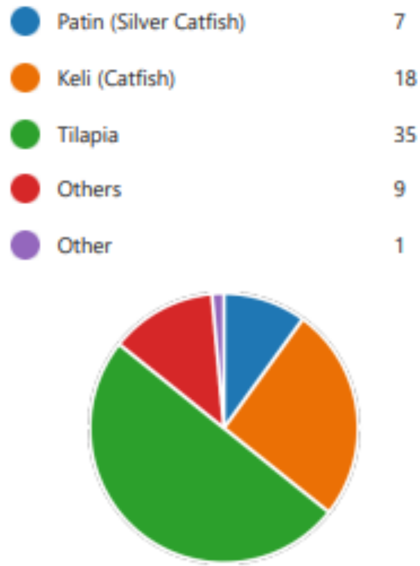


Figure 2.8: Pie Chart on type of fish preferred by respondents

14. Please answer if you choose "Others". Otherwise skip. (0 point)

9
Responses

Latest Responses

Figure 2.9: List of other type of preferred fish of respondents

15. How much do you willing to spend on an aquaponic system during food crisis (shortage etc)? (0 point)

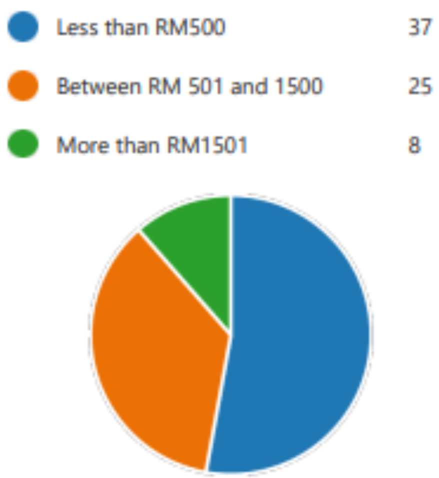


Figure 2.10: Pie chart on preferred expenditure of respondents on aquaponic system

16. Additional features that you want and consider to be included? Select "Others" if you want to do 2 or more. Eg: Solar Powered + UV Light (0 point)

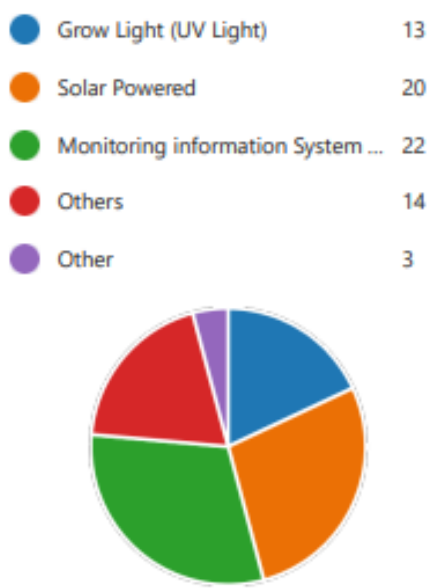


Figure 2.11: Pie chart on features preferred by respondents

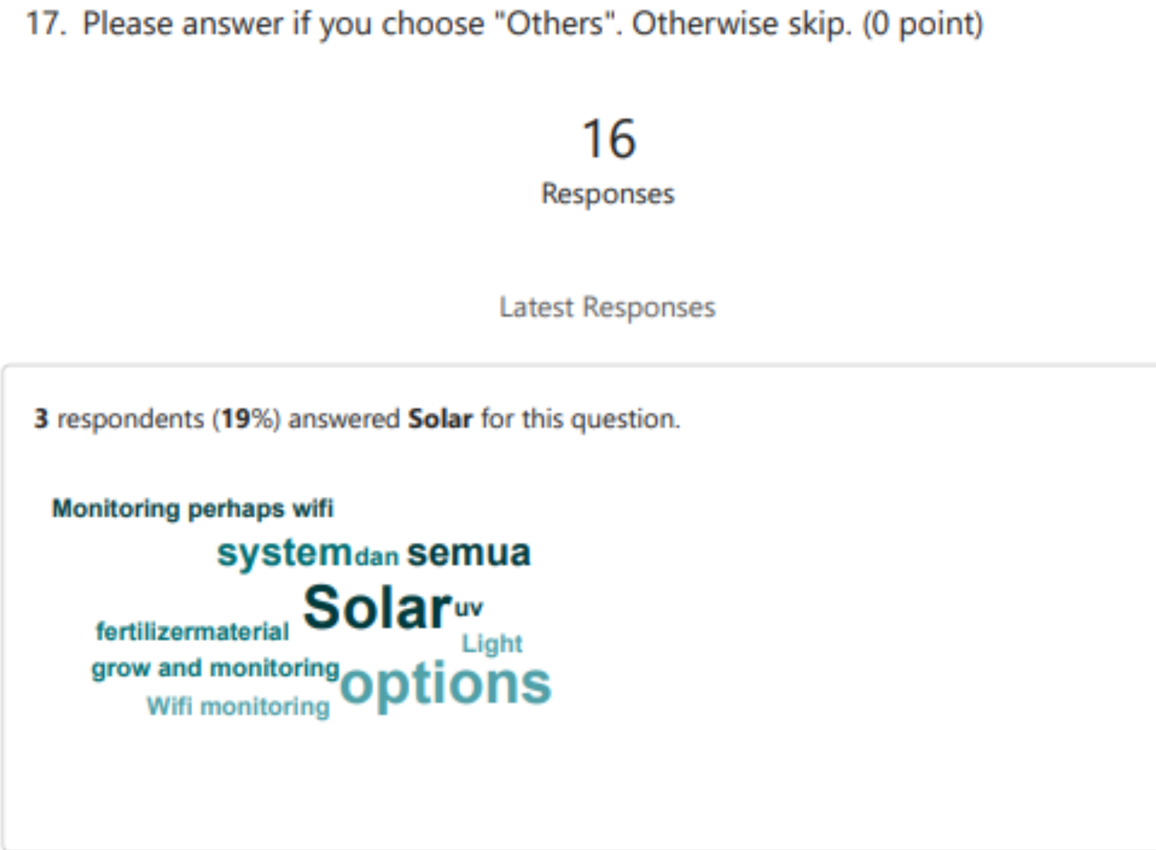


Figure 2.12: List of other type(s) of features preferred by the respondents

Based on the Figure 2.1, most of the respondents are identified as male with around 34 out of 70 respondents while another 4 of the total respondents decided not to reveal their gender identities. Other than that, the respondents are mostly aged between 21 to 24 years old following the age of 25 and above. From the total respondents, most of the response are students and employed citizens with around a total of 5 pensioner for this survey. Apart from that, a higher number of respondents lived in the city or urban area rather than rural area while 47 of them choose landed as their residential type and the remaining respondents in apartments or high-rise buildings. Therefore, we can assume that the survey is mostly completed by young adult who are likely to be students living in a landed city or urban area.

Then, further question was asked about their family monthly income to recognize their household income where the highest respondents of 24 respondents were identified with an average income of RM5001 and below. Since the number of respondents lived in the city or the rural area are more than others, it is expected for them to be familiar with the aquaponic system as they are more likely to be exposed to the usage of technology. Next, the respondents were asked if they have any experience with planting or rearing fish, in which most of them choose "No" as the answer. This is likely due to the insufficient space of living in the city or rural area as farming vegetables and rearing fish separately needed more space. Next, on Figure 2.5, most of the respondents shows an interest in the aquaponic system as most of the respondents agree to rear fish and plant their own vegetables during the food crisis.

Based on Figure 2.6, a list of vegetables was listed for the respondents to choose as their preferred vegetables in which many of the respondents picked 'others' following the next preferable vegetable is cabbage. In figure 2.7 showed the results of the extended question from Figure 2.6 where a collective of 5 respondent preferred Spinach as their vegetables for the system. Meanwhile in Figure 2.8, the respondents are likely to choose 'Tilapia' as their preferred fish while a total of 18 respondents choose 'Catfish' as their edible fish. In Figure 2.9 are the answer to the extended question in Figure 2.8, where a few other types of fish are listed with a sum of 9 responses with 4 same answers

Figure 2.10 is the expenditure that the respondents willing to spend for the system. A majority number of respondents willing to pay less than RM500 for the aquaponic system during the food shortage which is obvious to save their money as much as possible. Though, 25 students are willing to pay about RM501 to RM1500 for the system while 8 respondents are willing to pay higher than RM1501 for the aquaponic system. This shows that they believe that this system can help them during their food crisis.

The last two questions were on the additional features the respondents would like to add for the aquaponic system being around 22 respondents would like to have a monitoring information system to be installed in their system following the powered solar as the second additional feature to the system. In Figure 2.12, a total of 16 responses received with various answers such as wi-fi monitoring options. This will help us with the designing of the aquaponic system.

CHAPTER 3: DESIGNING

3.1 Basic Design Concept

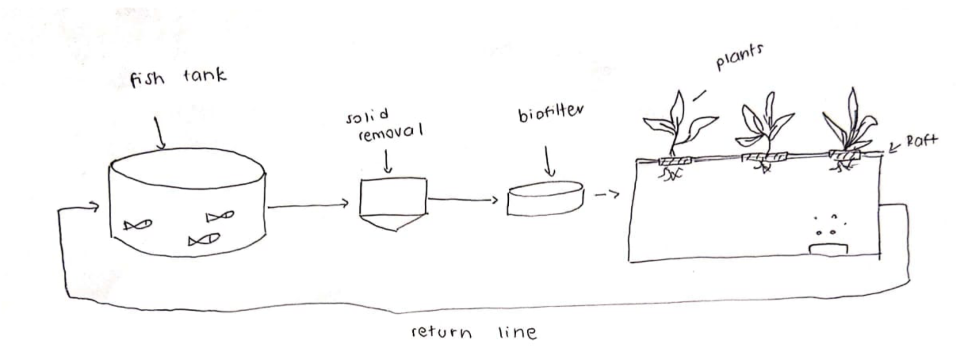


Figure 3.1: Sketch of Basic Design Concept of aquaponic

Fish are kept in tanks in an aquaponics system, and their waste is pumped to plants in gravel-filled grow beds. The nitrates are taken up by the roots, which then grow rapidly. The water is purified and returned to the tank. A full diet is provided by the organic vegetables and fish.

3.2 Alternative Design Concepts

3.2.1 Deep Water Culture (DWC)

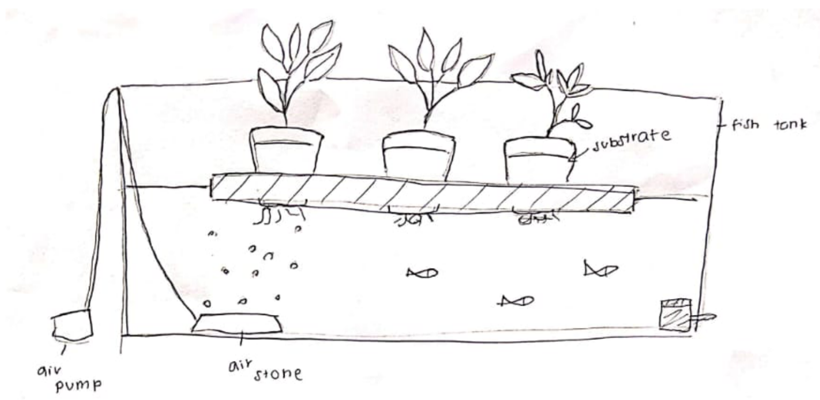


Figure 3.2: Design Concept for DWC

Table 3.1: Characteristic for DWC

PROS	CONS
Good for warmer tropical climates	Space efficiency
Inexpensive	Labor demand and cost
Not as susceptible to large temperature and nutrient fluctuations	Filtration demands

3.2.2 Drip System

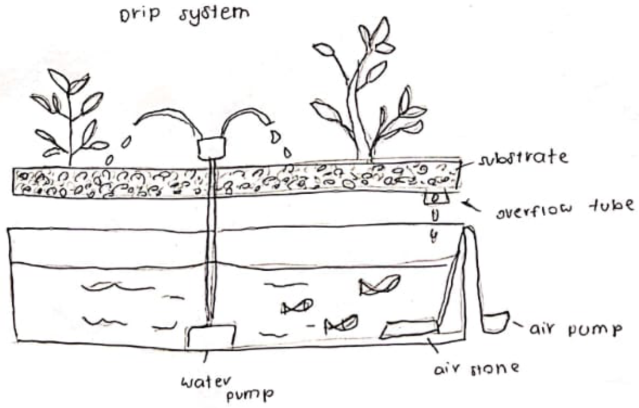


Figure 3.3: Design Concept for Drip System

Table 3.2: Characteristic for Drip System

PROS	CONS
Supplies more control over water and nutrient supply	If using non-recovery system, there is chance of waste
Requires modest maintenance compared to other methods	Method cannot be used with high iron content water because emitters become clogged
Affordable and cheap installation	Dependency on electricity

3.2.3 Nutrient Film Technique

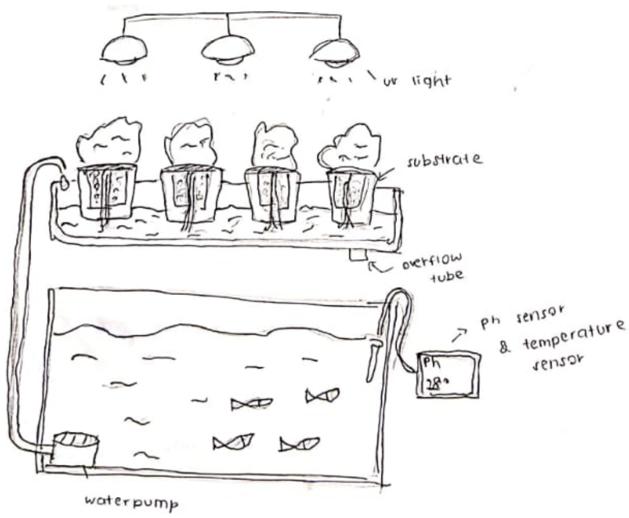


Figure 3.4: Design Concept for Nutrient Film

Table 3.3: Characteristic for Nutrient Film

PROS	CONS
Continuous supply of water, oxygen, and nutrients	Susceptible to clogging
Lower labor inputs	Higher possibility of water temperature fluctuation
Easy to access	Not suitable for larger or flowering plants

3.3 Chosen Design Concept

There are two main types of aquacultures and aquaponic, which marine and freshwater. For our project, we are solely focusing on the freshwater, as both vegetables and the proposed (species) of fish are also freshwater. Moreover, freshwater system is easier to keep worldwide, as the source of (fresh) water is plenty and obtainable. Aquaponics relies on the food introduced for fish, which works as the system's input. As fish devour this food and process it, they transform it into urine and fecal matter, both rich in ammonia, which in sufficient quantities can be toxic to plants and fish.

Afterward, the water (now ammonia-rich) flows, together with un-eaten food and decaying plant matter, from the fish tank into a biofilter. Afterward, inside this biofilter, bacteria break everything down into organic nutrient solutions (nitrogen-rich) for growing vegetables.

As we can see, aquaponics freshwater systems rely on 3 main components: freshwater aquatic animals (the fish), nitrifying bacteria, and plants – and all three living entities depend on each other to survive. Without the bacteria to consumer the fish waste, plants would not have a usable form of nutrients either – which is why biological filtration is crucial. And thanks to plant growth, nutrients are removed from the water, leaving it clean for the fish.

Based on the above, we can see that aquaponics mimics nature as the plant "kingdom" reuses the leftovers from the animal kingdom (fish) to close a circular loop. However, achieving the system's balance, keeping it, and securing best conditions for the fish and plans means a close control of different parameters. Thus, to ensure our prototype is working in harmonious, there are few main production parameters which need to be perfectly set to meet the best needs of plants and fish, such:

1. Air temperature

2. Water temperature
3. Concentration of macro and micronutrients
4. Dissolved oxygen in air and water (depends on the filtration method used)
5. CO2 concentrations in air and in the water
6. pH
7. Light

Chosen Design: Drip System

An operational hydroponic system is a drip system. This implies that it consistently watered and fed your plants with nutrients using a pump.

The emitters release the liquid in a gentle trickling motion as opposed to spraying or gushing water to the plants. This guarantees that the system utilizes a tiny amount of water. The amount of water and nutrients given to the plants is mostly under your control.

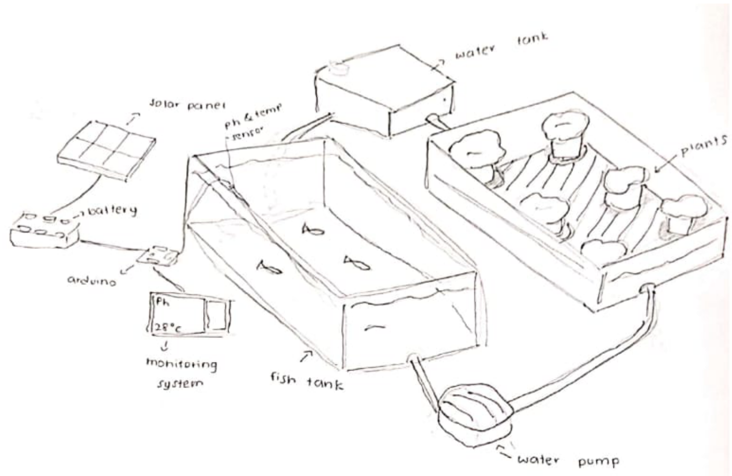


Figure 3.5: Illustration of Selected Design

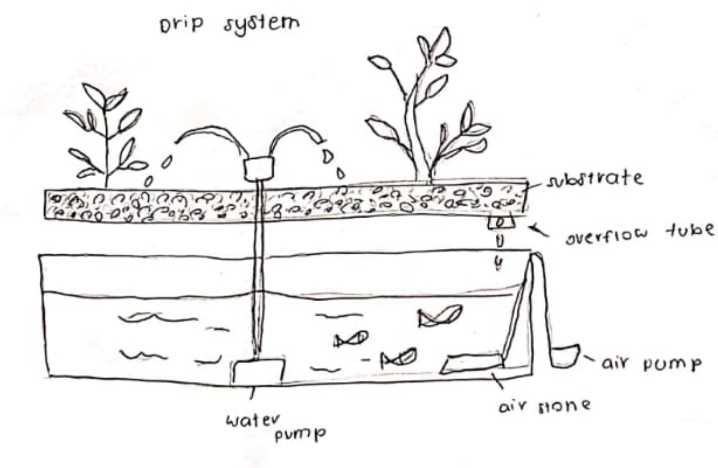


Figure 3.6: Illustration of Simplified Schematic System

Individual pots are typically used in the system for plants. A system of tubing carries water from the reservoir to the plants. The water supply can be pressed in two different ways. A gravity-based system or a standard water pump can be used. At least one specific drip emitter is provided for every plant. There are controls on each emitter that let you regulate the water flow. You can adjust different flow rates for distinct plants, which broadens the system's total adaptability. In a drip system, the flow to the plants must be controlled. Between flows, the expanding media needs time to catch its breath.

Individual pots are typically used in the system for plants. A system of tubing carries water from the reservoir to the plants. The water supply can be pressed in two different ways. A gravity-based system or a standard water pump can be used. At least one specific drip emitter is provided for every plant. There are controls on each emitter that let you regulate the water flow. You can adjust different flow rates for distinct plants, which broadens the system's total adaptability. In a drip system, the flow to the plants must be controlled. Between flows, the expanding media needs time to catch its breath.

Variation of the Drip System

In this project we are using **Recirculating/Recovery System**. The water that is added to the hydroponic medium is not entirely absorbed by the plant's roots. The extra water that is left in the medium is permitted to flow back to the reservoir in recovery systems. For simpler, at-home drip hydroponic systems, this type of system is highly popular. The method has certain shortcomings even if it uses water and nutrients more effectively.

The pH level of the reservoir water is impacted when the wastewater is let to flow back into the reservoir. This implies that you must regularly maintain recovery mechanisms. To make sure that the ideal pH and nutrient levels are maintained, the reservoir water will need to be tested. Smaller drip systems make this simpler and more affordable.

CHAPTER 4: PROJECT MANAGEMENT PLANNING

4.1 Tasks Listing & Distribution

Table 4.1: Members and Involved Tasks

TEAM MEMBERS	TASK DISTRIBUTION
Mohd Arief Bin Engah (Civil Engineering)	1. Project Manager 2. Leads meetings 3. Person in charge (PIC) for designing Department
Mariah Nur Adlina binti Mohamad Hafizan (Chemical Engineering)	1. Assistant Project Manager 2. Prepare Gantt Chart and task division 3. PIC for Project Management
Munna Farra Sofea binti Mohamad Nas (Chemical Engineering)	1. PIC for analysis of survey 2. PIC for Design Thinking Department 3. PIC for Capital Cost consideration
Prasad A/L Karuppayah (Materials Engineering)	1. PIC for Design Thinking Department 2. PIC for fabrication choices 3. PIC for Capital Cost consideration
Rizan bin Rudin (Computer Engineering)	1. PIC for Designing Department 2. PIC for Design concept 3. PIC for Identification of suitable tools and software
Yip Yan Leong (Mechanical Engineering)	1. PIC for Chapter 1 (Introduction) and Chapter 2 (Conclusion)

4.2 Gantt Chart

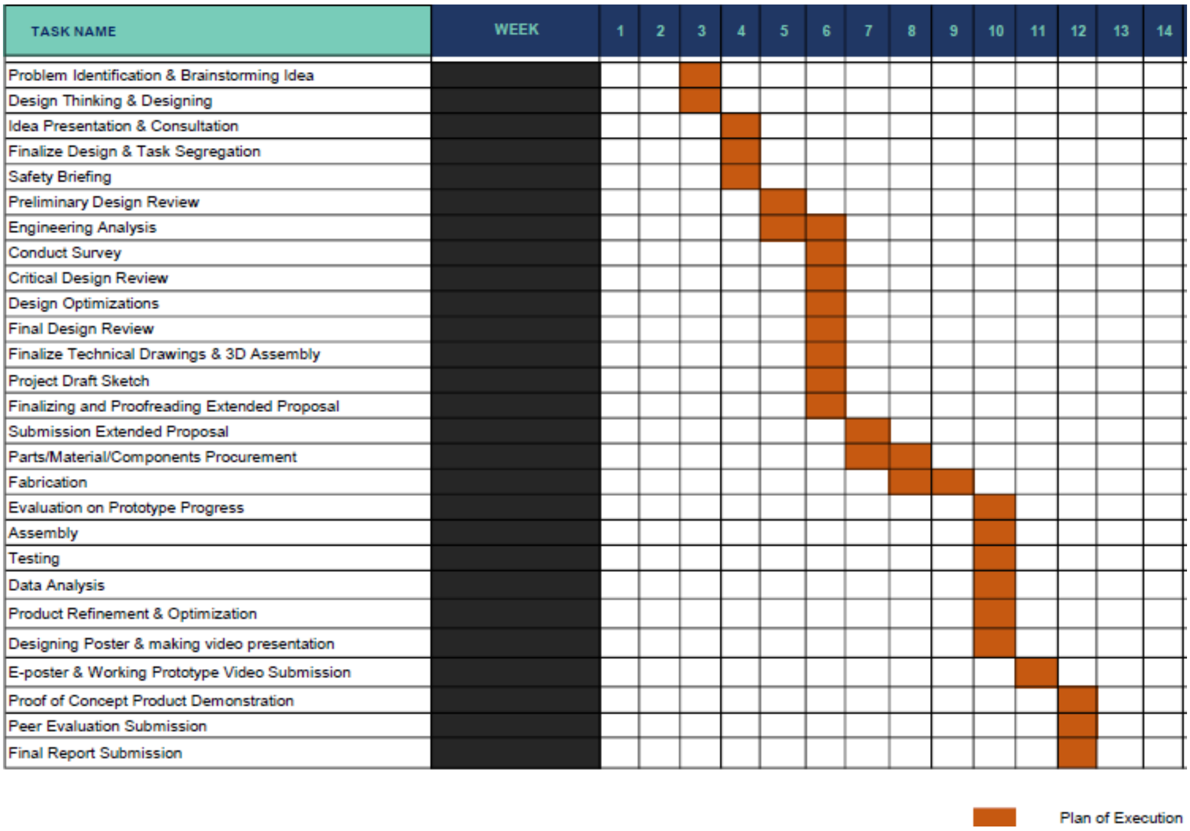


Figure 4.1: Gantt Chart of Project Milage

4.3 Feasibility Analysis

4.3.1 Operational Feasibility

The ability to use, support, and carry out the required activities of a system or program is known as operational feasibility. COVID-19 has been affecting Malaysia since early February 2020. The agriculture industry stayed open throughout the pandemic to ensure that food supplies were not disrupted. The movement control order (MCO), on the other hand, has restricted worker movement and food supply logistics. Furthermore, because of the high turnover rate, cultivating food needs a large workforce.

Fertilizers and insecticides are used extensively by farmers. Due to the weak value of the Malaysian Ringgit, most of these goods are becoming increasingly expensive. Therefore, we introduced our project which is Aquaponics as a solution for people during crisis. Aquaponics works efficiently as it does not need fertilizers to be supplied to the plants due to the nutrients provided from the fishes' waste product.

In addition, both vegetables and fishes can be consumed by the consumer in the aquaponics system. This could ease the people during the food crisis due to pandemic as well as giving the advantage to consumer to produce their own food that saves a lot of money and ensuring the quality of the food itself.

4.3.2 Technical Capability

For our system, as we are having limitation (funds, time and equipment), there are only a few things we (proposing) focused to monitor:

1. Automatic Water Pump
2. pH level

The targeted capability of the system is:

1. Water cycle (volumetrically) at least 10 times per day
2. Water temperature around ± 8° Celsius of ambient temperature
3. Area for growing plant is around 3 ft^2 to 12 ft^2 (0.28 m^2 to 1.12 m^2)
4. pH level kept around 6.2 to 8.5
5. Able to hold at least 6 fish
6. Minimum 30% of energy are solar powered
7. Overall (dry) gross system weight is less than 400 kilograms

4.3.3 Legal Feasibility

For this section, the (whole) legality of this project is confirmed to be obliged and abiding all laws, regulations, and rules of Malaysian Government and UTP.

The usage of materials is expected to comply as aforementioned. The species of fish(es) and plant(s) used are not in the list of protected, endangered nor controlled by the Malaysian Government. It is expected that there is no legal litigation could take place.

4.3.4 Scheduling Feasibility

The length of time it will take to finish a project is estimated by scheduling feasibility. Our project's planning and organization are based on the Gantt chart's deadline. In addition, the work progress is closely checked on everything that has been completed to ensure that the project is completed on time.

4.4 Technical Theory

4.4.1 pH Sensor

The pH Sensor resembles a rod with a "Glass membrane" tip that is often constructed of glass material. The buffer solution inside this membrane has a specified pH (usually pH = 7). This electrode layout ensures that H+ ions are consistently bound to the interior of the glass membrane. Hydrogen ions in the test solution begin exchanging with other positively charged ions on the glass membrane as soon as the probe is dipped into the solution being tested. This produces an electrochemical potential across the membrane, which is fed to the electronic amplifier module, which measures the potential between both electrodes and converts it to pH units. According to the Nernst equation, the pH value is determined by the difference between these potentials.

Nernst Equation

The Nernst Equation can be written as follows to describe how the glass electrode response behaves:

$$E = E0 - 2.3\ (RT/nF)\ \ln Q$$

Where Q= Reaction coefficient
E = mV output from the electrode
E0 = Zero offset for the electrode
R = Ideal gas constant= 8.314 J/mol-K
T = Temperature in ºK
F = Faraday constant = 95,484.56 C/mol
N = Ionic Charge

The standard cell potential, temperature, reaction quotient, and the cell potential of an electrochemical cell are all related by the Nernst equation. The Nernst equation is used to determine the cell potentials in an electrochemical cell under unusual circumstances. A complete electrochemical cell's total electromotive force

(EMF) can be determined using the Nernst equation. This formula is also used to determine a solution's PH level.

4.5 Engineering Analysis

The project is an aquaponic system that needs water to move through a water pump from the fish tank to the plants. Fish are kept in tanks, and the fish's waste is pumped to plants on gravel-filled grow beds. The roots absorb the nitrates and expand rapidly. Filtered clean water is returned to the tank. Fish and organic veggies make up a balanced meal. We have made a few tweaks or improvements to the system to make it work better and more easily for the user.

4.5.1 Mechanical and Electrical Engineering

a. Automatic Plant Watering System

An aquaponic system uses a water pump to transfer water from the fish tank to the plant. To manually turn on the water pump, however, the user must frequently monitor the system. People occasionally tend to forget things, such like turning on the water pump. after considering a number of solutions to this issue, as plants require water based on the soil's moisture content. Therefore, using an Arduino UNO, we created an automatic plant watering system.

This device uses a soil moisture sensor to gauge the soil's moisture content. When the soil becomes dry, a sensor that detects low moisture levels turns on the water pump to give the plant with water. When a plant receives enough water and the soil is sufficiently moist, the sensor detects that. following which the water pump will turn off automatically.

<u>Components</u>

- Arduino Uno
- Soil Moisture Sensor
- Relay Module

- Small Breadboard
- 12V Power Supply
- DC Water Pump
- Connecting Wire x11

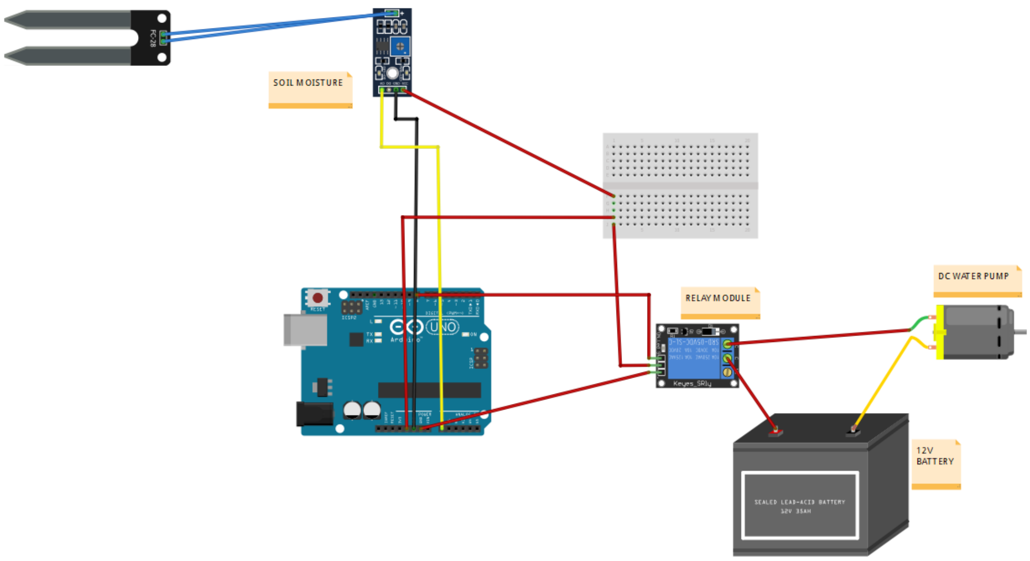


Figure 4.2: Circuit Diagram for Automatic Plant Watering System

Arduino Code

```
int digitalSensor = 2; //sensor pin
int pumpPin = 8; //relay pin

void setup() {
pinMode(digitalSensor, INPUT); //set pin 2 as INPUT pin
pinMode(pumpPin, OUTPUT); } //set pin 8 as output pin
}

void loop() {

  sensorValue = analogRead(digitalSensor); //set sensor value as sensorValue
  Serial.println("Analog Value : "); //print to display
  Serial.println(sensorValue); //print sensor value next to the text

  if(digitalRead(digitalSensor) == HIGH){ //read data from sensor and if HIGH
    digitalWrite(pumpPin, HIGH); // water pump will on
    delay(10000); //10sec
    digitalWrite(pumpPin, LOW); //turn off the water pump
  }
  else{
```

```
    digitalWrite(pumpPin, LOW); //if sensor reading is LOW,pump off
  }
  delay(8000); // 8sec
}
```

b. pH Sensor

To determine whether a solution is acidic or alkaline and express that information as pH, a pH meter examines the hydrogen-ion activity in water-based solutions. The pH meter is frequently referred to as a "potentiometric pH metre" because it detects the difference in electrical potential between a pH electrode and a reference electrode. The pH or acidity of the solution has an impact on the difference in electrical potential.

The hydrogen ion concentration in pure water, which has a pH of 7, is 107 gram-equivalents per litre, making it neutral (neither acidic nor alkaline). A solution with a pH below 7 is referred to as acidic, and one with a pH over 7 is referred to as basic, or alkaline.

<u>Ph Meter Building & Operation</u>

The Ph Sensor is often made of glass and has a rod-like construction with a bulb at the bottom that houses the sensor. A glass bulb that is specifically made to be selective to hydrogen-ion concentration is present in the glass electrode used to measure pH. Hydrogen ions in the test solution swap places with other positively charged ions on the glass bulb upon immersion in the solution under test, creating an electrochemical potential across the bulb. The electrical potential difference between the two electrodes created during the test is detected by the electronic amplifier, which transforms it to pH units. The Nernst equation states that the electrochemical potential across the glass bulb is linearly linked to pH.

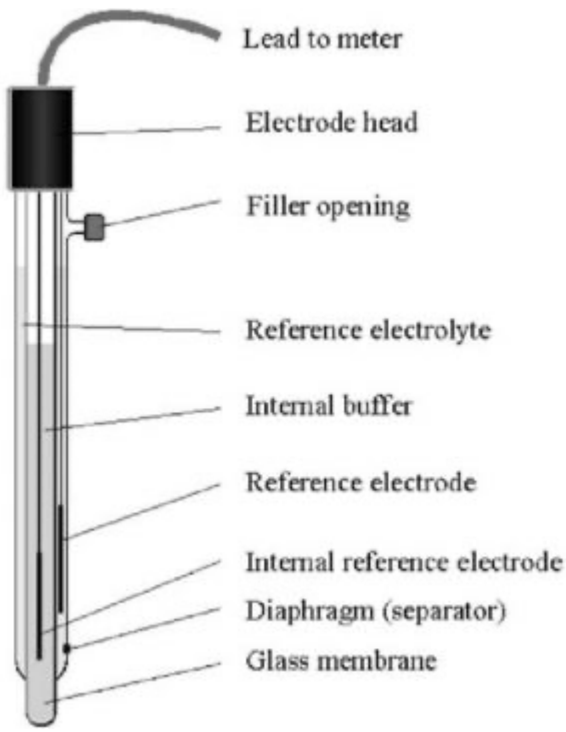


Figure 4.3: Structure of pH Probe

Since the reference electrode is made of a metallic conductor that is connected to the display, it is insensitive to the pH of the solution. The test solution is in touch with the conductor through a porous ceramic membrane while it is submerged in an electrolyte solution, commonly potassium chloride. Voltmeters that display voltage in pH units make up the display.

Components:

- Arduino UNO
- Ph Sensor Kit
- 0.96” I2C OLED Display
- Connecting Wires
- Breadboard

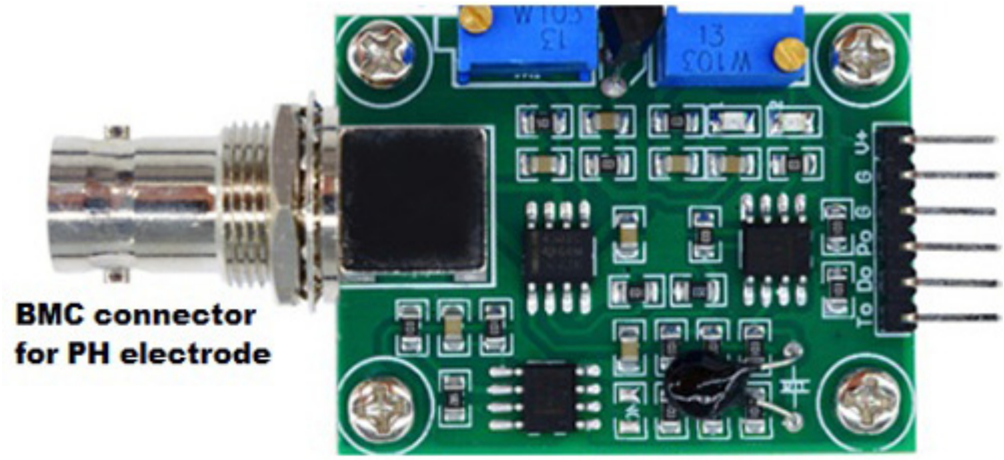


Figure 4.4: Structure of Ph Sensor

Pin Connection:

- **V+:** 5V DC input
- **G:** Ground pin
- **Po:** pH analog output
- **Do:** 3.3V DC output
- **To:** Temperature output

Arduino Code

```
#include <Wire.h>
#include <Adafruit_GFX.h>
#include <Adafruit_SSD1306.h>

#define SensorPin 0 //the pH Analog output is connected tothe Arduino’s Analog
float calibration_value = 19.7;
int phval = 0;
unsigned long int avgval;
int buffer_arr[10],temp;

#define SCREEN_WIDTH 128  // OLED display width, in pixels
#define SCREEN_HEIGHT 64  // OLED display height, in pixels
#define OLED_RESET    -1  // Reset pin # (or -1 if sharing reset pin)
Adafruit_SSD1306 display(SCREEN_WIDTH, SCREEN_HEIGHT, &Wire, OLED_RESET);

void setup()
{
  pinMode(13,OUTPUT);
  Serial.begin(9600);
  Serial.println("Ready");    //Test the serial monitor

if(!display.begin(SSD1306_SWITCHCAPVCC, 0x3C))
{
```

```
    Serial.println(F("SSD1306 allocation failed"));
    for(;;); // Don't proceed, loop forever
}
 display.display();
 delay(2);
 display.clearDisplay();

display.clearDisplay();
display.setTextColor(WHITE);
display.setTextSize(2);
display.setCursor(0,5);
display.print("PH Sensor");
display.display();
delay(3000);

}
void loop()
{
 for(int i=0;i<10;i++)
 {
   buffer_arr[i]=analogRead(A0);
   delay(30);
 }
 for(int i=0;i<9;i++)
 {
   for(int j=i+1;j<10;j++)
   {
     if(buffer_arr[i]>buffer_arr[j])
     {
       temp=buffer_arr[i];
       buffer_arr[i]=buffer_arr[j];
       buffer_arr[j]=temp;
     }
   }
 }
 avgval=0;
 for(int i=2;i<8;i++)
 avgval+=buffer_arr[i];
 float volt=(float)avgval*5.0/1024/6;
 float ph_act = -3.2 * volt + calibration_value;//convert millivoltto pH value
  Serial.print("    pH:");
  Serial.print(ph_act);
  Serial.println(" ");

  display.clearDisplay();
  display.setTextSize(2);
  display.setCursor(20,0);
  display.println("Ph Value");

  display.setTextSize(3);
  display.setCursor(30,30);
```

```
  display.print(ph_act);

  display.display();
}
```

<u>Calibration of Ph Electrode</u>

In this project, the PH electrode calibration is crucial. We must have a solution for this whose value is recognised to us. For the calibration of the sensor, this can be used as the reference solution.

Consider a solution with a PH value of 7. (distilled water). When the electrode is now submerged in the reference solution, the LCD shows a PH value of 6.5. Simply add 7-6.5=0.5 to the calibration variable "calibration value" in the code to calibrate it. i.e., change 21.34 + 0.5 to 21.84. Re-upload the code to Arduino after making these modifications, and then check the pH by dipping the electrode in the reference solution. Now, LCD should display the proper pH value, which is 7. (Little variations are considerable). The sensor should also be calibrated by adjusting this value. Then, to obtain the precise result, examine all other alternatives.

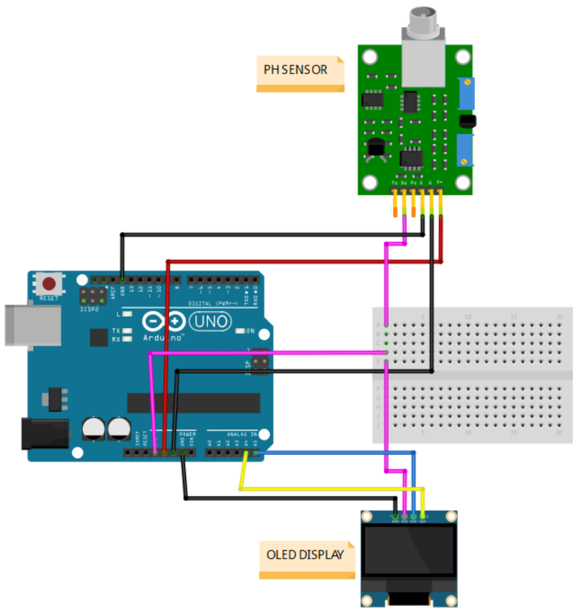


Figure 4.5: Circuit Diagram of Ph Sensor With Display

4.5.2 Civil Engineering

Designing and planning for this project, Autodesk AutoCAD and Fusion 360 has been used to create dimension plan, 3D plan as well as preparing for the R12 file to be used to create laser printing and cutting plan of the Perspex. The Perspex thickness used in this design is 6 mm for the growing bed.

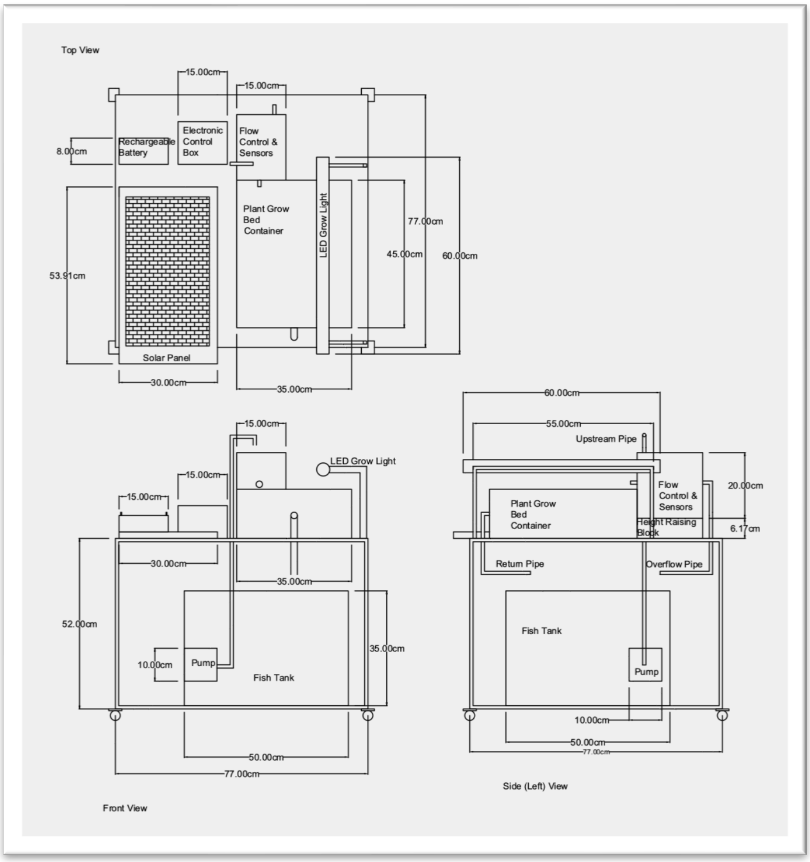


Figure 4.6: Schematic Plan of design using AutoCAD

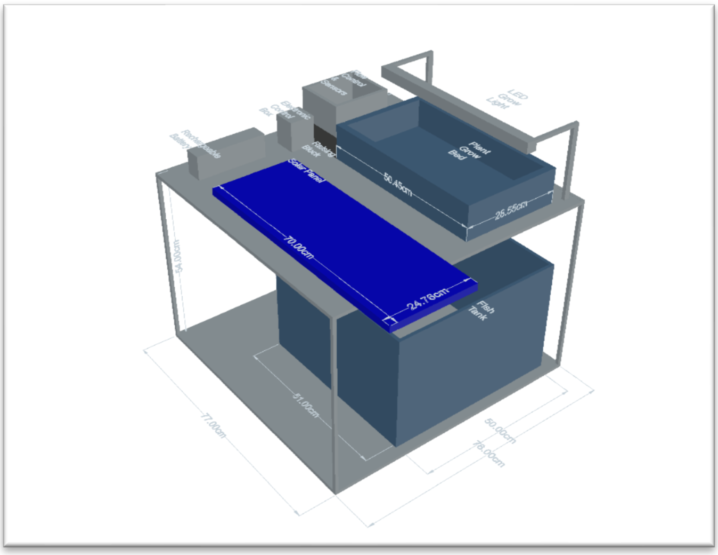


Figure 4.7: 3D plan view of proposed design using AutoDesk Fusion 360

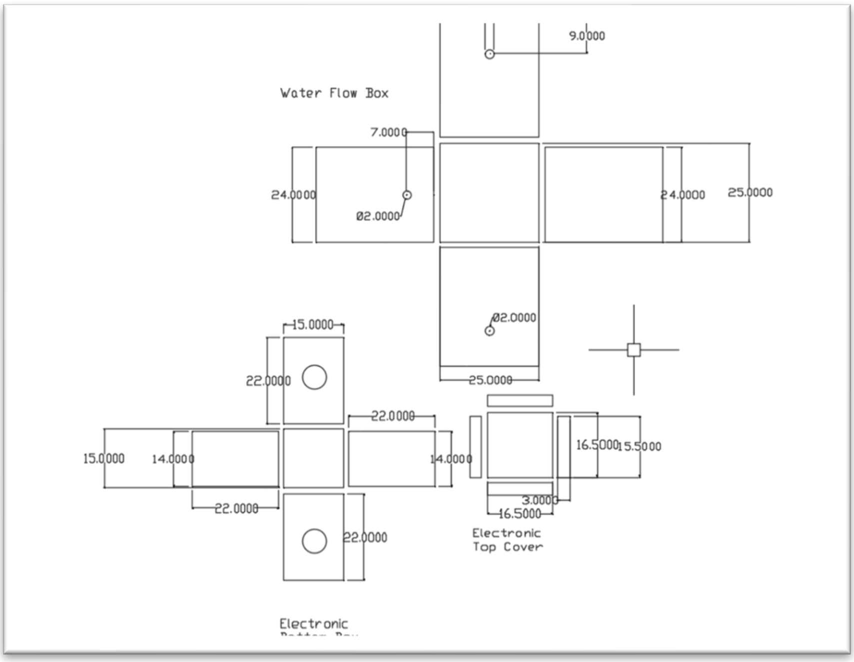


Figure 4.8: Drawing file R12 used for laser cut machine (Perspex)

CHAPTER 5: PROJECT METHODOLOGY

5.1 Project Flow

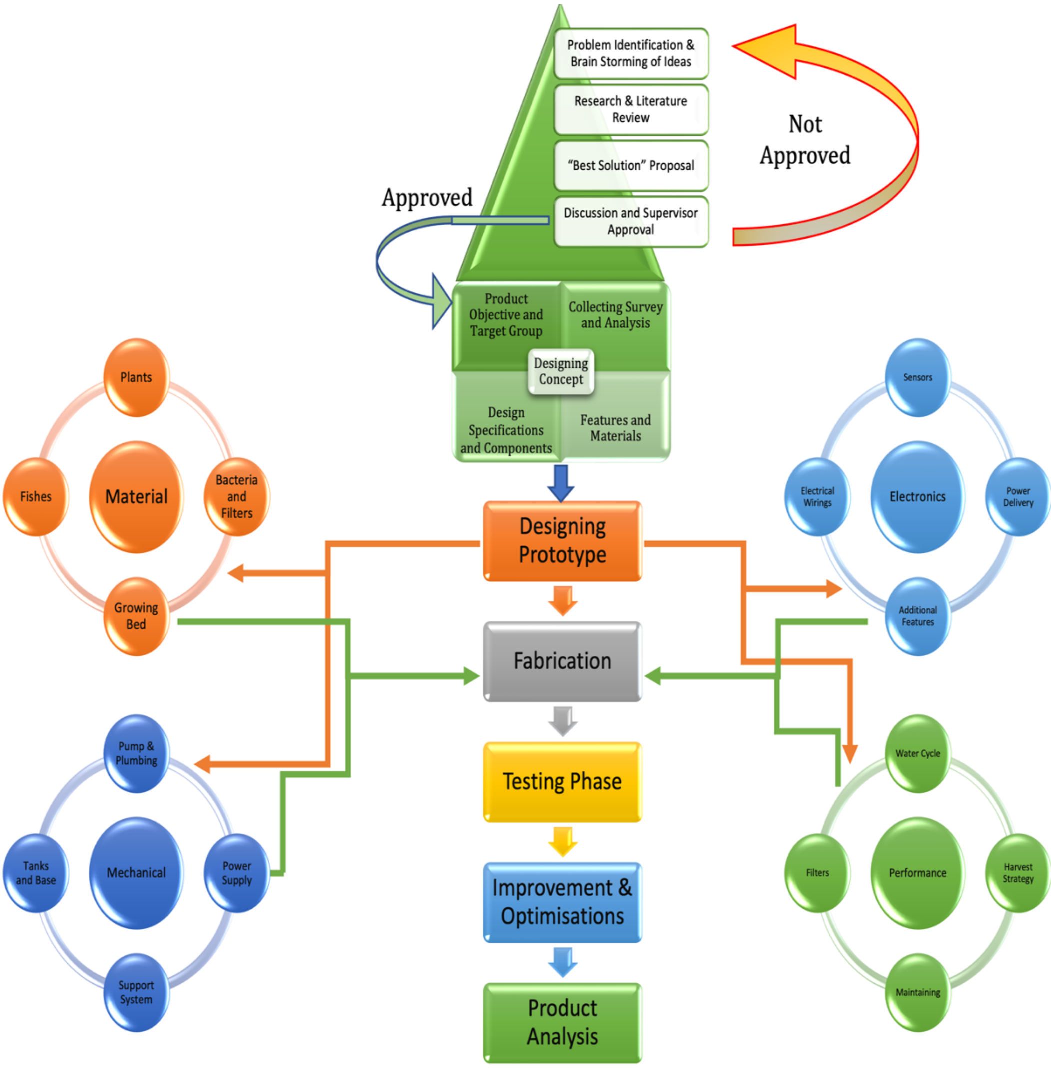


Figure 5.1 : Flowchart of the project

The flowchart in Figure 5.1 shows the simplified schematic project workflow. In the beginning, the flow was started by finding the underlying problems of current issue and brainstorming the ideas from each member. After finding and coming up with a few ideas, the ideas were presented to the project supervisor. With regards to the supervisor's advice and suggestions, our team decided that the study and development of an aquaponic system must be done. Each member's pair had produced a sketch of their design ideas as well as its properties and technical advantages, which includes the rough dimension, weight, efficacy and the (target) application of the product. The decision on the design and its properties were decided among the team members by using a design decision matrix. The selection criteria for the matrix were performance, functionalities, design, and size. After the designing concept has done, we are now moving into the designing prototype and starting to assemble the aquaponic system based on the feasibility and essentialness.

5.2 Identification of Suitable Tools and Software

5.2.1 Materials and Hardware

Table 5.1: Hardware and Material to be used

No	Materials	Quantity	Function
1	Arduino UNO	1	Used in construction of sensors and actuators
2	Ph Sensor Kit	1	used to measure the acidity and basicity of a the water.
3	OLED Display	1	To display the pH value on the OLED display module
4	Connecting Wires	1	Connect the circuit
5	Fish Tank	1	To keep the fish
6	Water Pump	1	deliver nutrients to the plants
7	Solar Panel	1	used to power the electrical components
8	Water Tank	1	Self-explanatory
9	Relay Module	1	It enables the water pump to be managed by the Arduino board. The relay's job is to turn on or off the pump that transfers water from the fish tank directly to the plants.
10	Air Pump	1	Powering air stones
11	Air Stone	1	Circulate the air around your fish tank
12	Soil Moisture Sensor	1	measures soil moisture to trigger the automatic water pump
13	Seal Lead Acid (SLA) 12V Battery	1	For the system to function, supply electric power to devices such the air pump, Arduino, and water pump
14	Glue	1	To attach any components specifically the Perspex used to create the basement prototype.
15	Laser-cut	1	To cut the Perspex according to the desired measurements and make sure all edges have smooth finishing

16	Solder	1	used for electrical connections, such as soldering wire to printed circuit boards
17	Cutter Knife	1	for grasping, cutting, splicing, and stripping wire insulation

5.2.2 Software

Table 5.2: Software utilization

Software	Function
Arduino IDE	To program the coding for Arduino
Microsoft Office Excel	The data obtained from the completed Microsoft Forms Survey is tabulated and organized in Microsoft Excel, which will subsequently be utilized to analyze and assist us through our design processes
Microsoft Office Word	Microsoft Word is used for a variety of project papers, including extended proposals, project planning, note annotations, and more. Predominantly, it is used to prepare the project proposal as well as to track the project's continuance.
Microsoft Form	Used to create the project's flood-survey, invite people to fill in using practically any web browser or mobile device, see real-time results as they're completed, utilize built-in analytics to analyze results, and export data to Excel for further analysis or grading.
Autodesk AutoCAD	This tool can be used to simulate and present the project in 2D and 3D drawings of our flood barrier and its segments in detail when the fundamental designs are completed. This software is used to develop the project, which contains detailed component labelling and measurement. Additionally, the user may arrange or overlay items, retain items in a database for later use, and alter object properties like as size, shape, and orientation.
Fritzing	Create a schematic, and subsequently a part, that can be included to wiring schematics that are extremely professional-looking.

5.3 Justification of Fabrication Choices

Table 5.3: Fabrication and choice reasoning

No.	Fabrication	Justifications
1	Fiber glass fish tank	Fiber glass is a long-lasting material and is less affected by severe weather conditions. These properties will favor a fish tank in an aquaponic system.
2	Plastic crate	Plastic crates come with large area for the roots of the plants to grow into. It also is a very sustainable material. These properties are what attention is paid most to when choosing a growing bed. The growing bed is where the plants will grow in an aquaponic system.
3	Hydroton clay pebbles	Hydroton clay pebbles is the popular choice of growing media used in an aquaponic system. Hydroton clay pebbles ensures good root aeration, enhances microbial action in aquaponics, prevents rotting, prevents excess acidity, and offers high water storage properties and balanced capillary action. Properties of the hydroton clay pebbles favors it to be chosen as growing media.
4	PVC pipe	PVC pipes or guttering material in which holes are made to hold the plants. Plants are firstly placed into net cups which are then placed into the nutrient-rich water within the pipes that is flowing from the fish tank. These pipes are essential to an efficient aquaponic system.
5	PVC fittings	These fittings are designed to change the end type of a pipe, allowing it to connect to fittings and pipes of many sizes. They can have threaded or slip socket ends to connect to an endless variety of pipes and fittings. These fittings hold the PVC pipe in place.
6	Uniseals and bulkheads	Uniseals are used to attach pipe to any container in situation where bulkheads will not work. The most common use is on curved surfaces such as storage drums, buckets, or even other pipe. To connect the PVC pipe to the fish tank for the water to flow to growing bed. The uniseals are a crucial part to the system.

CHAPTER 6: ECONOMICAL CONSIDERATIONS

6.1 Capital Cost Considerations

The cost of our prototype is considered and estimated using a reliable method such as by surveying the local price of the materials around town. Most of the materials like temperature and pH sensors are available in an aquarium store which is convenient and widely available. In Table 6.1, shows the basic list of materials that are needed for the aquaponic system. The capital cost is fixed at only one time to be installed. Therefore, it is the overall expense that is needed to build this project into the commercial services. In this part, the team project has determined the primary cost of constructing the project where all the parts are to be bought separately.

Table 6.1: Price estimation of the materials

No	Item	Quantity	Cost Per Item (RM)	Total cost (RM)
1	PVC Piping	4	1.90	7.60
2	Water Pump	1	71.00	71.00
3	PVC Fittings	8	1.10	8.80
4	Uniseals & Bulkheads	2	52.97	105.94
5	Clay Pebbles (Substrate/ Grow Medium)	2kg	8.00	16.00
6	Plastic Crate (Grow bed)	1	4.50	4.50
7	Air Pump	1	45.95	45.95
8	Siphon	1	7.35	7.35
9	Spinach Plant	4	4.00	16.00
10	Tilapia	10	20	200
11	Overflow Tube (Silicone Tube)	1	9.98	9.98
12	UV Light	1	29.48	29.48
13	pH sensor	1	26.92	26.92
14	Temperature Sensor	1	4.91	4.91
15	Trolley (to move the prototype)	1	190	190

6.1.2 Additional Materials

In Table 6.1.2, are the additional features or materials that are not necessary for the project yet can be installed to ensure the vegetables are in a good condition. As the basic materials listed above has included clay pebbles as the growth medium, it is described as an excellent medium to that could supply adequate growth to the plants.

Table 6.2: Additional Materials for the project

No	Item	Quantity	Cost Per Item (RM)	Total cost (RM)
1	Soil pH sensor	1	200.80	200.80

6.2 Operational Cost Considerations

For this product to be commercialized, there are few costs consideration that needs to be taken into account. We are considering to be based in Seri Iskandar, Perak, Malaysia. Our operational costs can be categorized in several diverse ways. Table below illustrate our (projected) monthly operational cost should this to be commercialized. Cost is based on commercial and industrial rate.

Table 6.3: Estimation of Operation Cost

Item	Details	Unit Price (RM)	Price (RM)	Notes
	Fixed Cost			
1	Store Rent Space		1200	1400 sqft, 2-Storey Shop at SIBC 18
2	Utility Cost (Power, Water, Internet)		3000	
3	Workers Monthly Payroll	1550	6200	4 employees
4	Equipment Depreciation		350	Machineries and devices
	Variable Cost			
5	Materials		850	
6	Delivery/Shipping/Logistics		2500	
7	Advertising and Publicity		1000	
	TOTAL		15100	
8	General Overhead		1510	10% Total Cost
	GRAND TOTAL		16610	

From the above table, we can see that for the commercialization of this product, the monthly operation cost would be starting at RM 16,610.

6.3 Other Considerations for Limited Production Facility (Everyone)

6.3.1 Alternatives In Species

6.3.1.1 Catfish

Catfish are excellent at adjusting to their surroundings, are not territorial, and reproduce quickly. They can withstand a wide range of water temperatures and come in several breeds that are ideal for different environments. Other than that, Catfish is a well-known species with a proven market acceptance. As a whole fish, catfish has a high fillet yield and dress out percentage. The difficulty with catfish, on the other hand, is a static selling price and intense competition inside an already well-established market. It is impossible for a modest aquaponic enterprise to be economical given current catfish output and sale prices. Sales of catfish may be able to pay feed expenditures, but not system or operational costs. Catfish also requires high protein foods in their pellets.

6.3.1.2 Largemouth Bass

Largemouth bass can withstand a wide range of temperatures, oxygen levels, and pH levels. Largemouth bass, on the other hand, prefers clear water. They are carnivorous fish who need a lot of protein in their diet. Largemouth bass growth rates are influenced by temperature and feed quality. However, with largemouth bass, changes in the potassium levels of bass should be watched because they can make them sick. Bass also have poor feeding habits and do not tolerate bright light.

6.3.2 Alternatives in Sensors

6.3.2.1: Arduino

From the adequate amount of research found that Arduino can be replaced with the temperature sensor as Arduino will automatically measure the temperature of the fishes and its relative conditions. Arduino can also be found to estimate the pH sensors and others.

6.3.2.2: Solar Water Pump

This material is convenient as it saves electricity and provide a greener selection for the power usage. Even though it is dedicated for the water pump, it is found that it can also measure pH sensor and temperature. Although, the materials for the solar pH sensor and temperature are unavailable within this country. Somehow, the cost of this water pump is relatively higher than regular water pump though, it saves more electricity than the other.

6.3.2.3: 4-in-1 Sensor

The 4-in-1 sensor is a one-piece material that has all the sensor needed to evaluate and calibrate the condition of the water inside the tank. It is a reliable and a good bargain as it monitors the water quality by ensuring the pH level, temperature, TDS, and EC.

6.3.3 Alternatives in Species of Plants

6.3.3.1: Bok Choy

Bok choy is a popular Chinese cabbage that is an excellent choice for aquaponic. Although Bok choy is a little heavier, it is still one of the best plants to grow in an aquaponic system. A good growing media must be used to make sure the book choy grows and stays intact. A sturdy growing bed is needed as well as the Bok Choy plant is heavy. Grow time for Bok choy is 8 to 11 weeks from seed.

6.3.3.2 Ginger

Ginger grows well in media bed aquaponics systems which can structurally support its roots as it grows. Ginger thrives in a humid and warm environment and does not need full sunlight to grow.

6.3.3.3 Beans

Beans are extremely easy to grow and care for, and there are many varieties for you to choose from. It requires full sunlight to grow and like receiving at least 6 to 8 hours of sun every day. Beans are divided into two types- bush and pole beans. Pole beans are ideal for aquaponics because, with them, you can maximize your growing space. However, you must provide them with a support stick so that they can grow upwards and take up less space on the grow bed.

CHAPTER 7: RESULTS & DISCUSSION

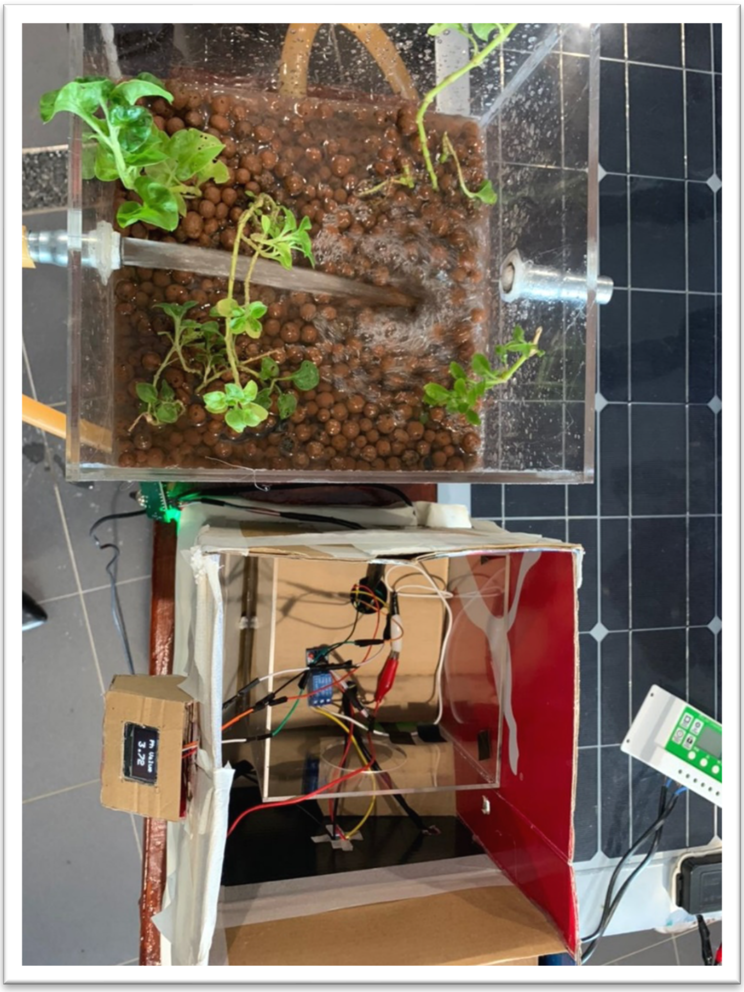


Figure 7.1 7: Top view of the prototype

As we see in the photograph above the aquaponic system manage to produce healthy spinach plants. This is because the system is equipped with a bunch of electrical components, like a PH monitoring system which monitors the Ph level of the water where in the fish tank.

The pH range for most tropical freshwater aquarium fish is 6.8 to 7.8, while certain fish may require higher or lower levels. The simplest strategy to stop the pH of an aquarium from dropping over time as a result of the decomposition of organic material is to do frequent partial water changes.

Figure 7.2: Side profile of the prototype

The trolley which was fabricated specifically for containing the aquaponic system consists of two levels. The lower level is where the fish tank is placed and the upper level is where the grow bed and the electrical box and the solar panel is placed. The electric box is where all the wire and circuits are situated. All of the electrical components like the air pump, submersible water pump and the ph monitoring system is all powered by the solar panel. Solar panel is also situated on the upper level of trolley beside the electrical box.

Figure 7.3: View of the electrical component box

Above is all the electrical components in the electrical box, Ardunio is also placed in the electrical box. Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs. In our aquaponic system the arduino board is used to control ph sensor, air pump and water pump.

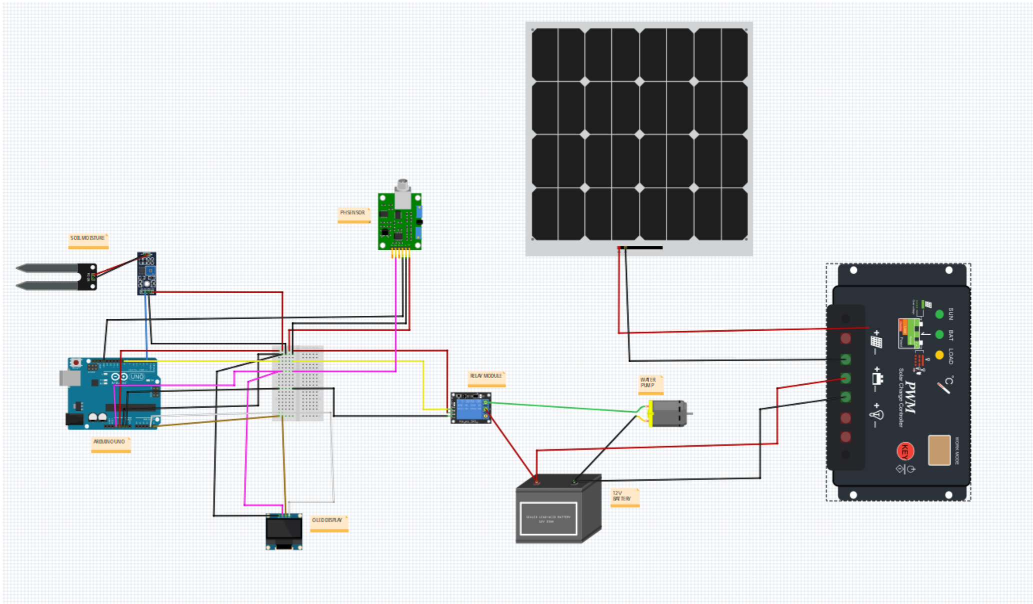


Figure 7.4 8: Full Electrical Diagram of The Prototype

<u>Solar Panel Installation Design & Calculations</u>

Load Specification:

Item	Water Pump	Arduino
Type of Current	Alternating Current (AC)	Direct Current (DC)
Voltage	220V – 240V	5V
Watts	18W	0.4
Frequency	50Hz	16Mhz

Battery Specification:

Item	Battery
Voltage	12v
Amp Hour	7.2
Initial Current	Less than 2.1A
Standy Use	13.6 – 13.8

Capacity = 12V x 7.2Ah = 86.4Wh

Backup time = 86.4Wh / 37.5W = 2.3 Hours

Solar Panel Specification:

Item	Solar Panel
Voltage	12V
Watts	1000w
Current	20A

Number of Panel	1

Figure 7.4: Solar panel setup

Hydro ton clay pebbles are used as growing media. This was chosen as grow media because these pebbles ensures good root aeration, enhances microbial action in aquaponics, prevents rotting, prevents excess acidity and prevents soil pests. The pebbles also offer high water storage properties and balanced capillary action. This is one of the main reasons the spinach plant growth is efficient.

CHAPTER 8: CONCLUSION

Nutrient deficiency and algae growth for short has become the biggest concern for every nation. The potassium deficiency is come across for many years have been mark as a food security crisis. The permanent flaw that caused enduring deficiencies in diet and diminished the food security of average citizen. The initiative of these citizen strengthened by government policy and created an urban agriculture movement. This designed to improve produce ability in a sustainable system. Despite for those efforts, a shortage of essential nutrient remains. Our proposition improves the productivity of urban gardens while support the practice with aquaponic. The system also creates regulated symbiosis between vegetation and cause the livestock to increase. This system is a closed loop system, which called recirculating aquaponic, is to circulate in water tank with the plant on it.

Water flows continuously through the aquarium, filtration, system component and back to the aquarium. This is the most common aquaponics that is no harmful environmental impact but also transmitting the device and serve as source when seems to take some time. This fact provided that the present system of nitrifying bacteria in aquarium which can convert fish waste which enters the system as ammonia into nitrates act as fertilizer for the plant. In conclusion, our team had designed a aquatic system so the aquaponic process become more efficient, equipped with better component to fully capable to deal with insufficient source of supply.

Feasible toward to community in this country and capable of reducing labor work. This is an aquaponic that will be a better choice in sale for current product. The device included 4-in-1 sensor that detect and record temperature, humidity, and light level. Another then that, the device to reduce labor work from adding solar water pump which can save electricity while measuring the temperature and pH level at the same time. Also equipped with the device UV sensor had plan for making a fully automated and database for collecting status. Thus, the device for the process of keep tracking the situation of the aquarium. We ensured that the plant and fish in healthy life and better improvement for our resistance to climate change. With this device, we are also not afraid of threat concern and can reduce the transmission of the disease from water and plant as well as hoping with this aquaponic system we can make live a healthier and more effortless. Our fabrication process was considered as a success and the objectives that were proposed are achieved, however there are several recommendations and better amendments that can be implemented on our prototype features.

CHAPTER 9: RECOMMENDATIONS

There were various issues encountered while building the prototype, as well as several places that may be used for future improvements. This is also appropriate for the purpose of building the prototype, which will cause a number of issues to emerge and a number of recommendations to be considered.

Firstly, to improve the convenience of our prototype, the tidiness and safety aspects of the prototype need to be taken into account. In order for the product to be convenient, user-friendly and able to be commercialized, some changes need to applied to the design and finishing of the product. Our prototype were connected and assembled mainly using hot glue gun, insulating tape and masking tape. Due to low budget and time constraints, the process of assembling the prototype parts were connected using light and weak adhesives. Therefore, for future improvements, better connectors and adhesive materials shall be used to ensure the safety and quality of the prototype to meet the user's expectations. Silicone and polymer materials can be used to connect the parts. The rubber pipe used to flow the aquaculture effluent to the hydroponic component could also be substituted with better and more sturdy materials such as PVC pipe.

Secondly, although the fish tank was chosen accordingly to the size and number of fish, the height of the tank should be ensured to be tall enough to prevent the splashing water from the tank due to the pump. This also serves as better safety aspects for the user to prevent any problems and accidents due to the splashing water that came out from the tank that may cause slippery floor, especially if our product is used in a home and reachable for the kids.

Thirdly, the trolley capacity and maximum weight also need to be calculated more precisely to ensure it could withstand the whole prototype's weight. Our prototype's trolley encountered problems such as broken wheels as it cannot hold the weight of the prototype that resulted to the difficulties for the mobility and transporting the prototype from one place to another. For future improvements, bigger and sturdy wheels can be used to ensure it could withstand the load of the product for a long time.

In short, although our prototype was a success, there is certainly room for improvement. In order for the prototype to be commercialized and used by the intended users, the suggestions given above should be considered.

CHAPTER 10: REFERENCES

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APPENDICES