CHAPTER I
INTRODUCTION

1.1 Project Background

Agriculture and fish farming are two countries leading sectors, especially in Southeast Asia. This sector can provide considerable income for the country's economy. Agriculture and fish farming are not only managed by large industries but also by small and medium enterprises. However, agricultural and fishing land declined due to the rapid expansion of land to build industrial plants and other structures. The reduction of agricultural land and fisheries has reduced agricultural turnover, especially in vegetable and fish farming. The demand for vegetables continues to increase along with the population and awareness of nutritional needs.

On the other hand, the vegetable yield is not enough to meet the needs and demands of the market (Atmaja et al., 2021). With the shrinking amount of agricultural land in urban areas that can be used, land use has become an option to support agricultural development in urban areas. This land use achieves food security for the population starting from the household scale (Saifudin, 2016). This land use method can use vertical farming combined with fish farming.

Vertical farming solutions in agriculture are a way out of the difficulty of opening agricultural land, especially when combined with aquaculture. Nutrients in fish waste can be used as nutrients for plants. Fish waste allowed to settle in the pond will be toxic to fish. Another benefit of plants is that they act as filters to remove toxic substances found in ponds and provide an additional oxygen supply in the water used to raise fish. This cycle is called the cycle of mutualism or mutual benefit between plants and fish (Saifudin, 2016). The basic principle is that the rest of the feed and fish waste, which worsens water quality and leads to fish death, will be used as fertilizer for plants. This is done through a water recirculation system that flows into the growing medium, which also filters the water so that when it returns, it is clean of ammonia and more suitable for fish farming[Megawati et.al., 2020].

This technology improves the efficiency of maintenance and control, resulting in higher productivity and yield quality for vegetables and fish. Furthermore, without having to control plants or fish directly, based on background and solutions for the development of urban agriculture, Internet of Things (IoT) technology answers the above problems to overcome maintenance processes that take longer and will facilitate some maintenance processes(Saifudin, 2016; Megawati et.al., 2020).

The Internet of Things (IoT) is an activity where actors interact with each other through the Internet (Widiantara et.al., 2021). The Internet of Things (IoT) is a network of physical objects. The Internet is not just a computer network; It has developed into a network of devices of all types and sizes: vehicles, smartphones, household appliances, toys, cameras, medical devices, industrial systems, animals, people, and buildings, all connected, all communicating and sharing information based on protocols to achieve intelligent reorganization, positioning, tracking, safe and controlled operation, even personal real-time online monitoring, online updates, process control, and administration. In this study, researchers aim to develop vertical farming combined with aquaculture, supported by IoT systems.

1.2 Problem statement

In this modern era, the need for land use for urban development is greater than the available land, so agricultural land is sacrificed to construct human civilization. The use of agriculture carried out on land, or traditional agriculture, is very unlikely due to the limitations of existing land, not only the shortcomings of traditional agricultural use such as water irrigation systems that are not ideally regulated so that plants do not absorb most of the water used but evaporates, continuous soil degradation resulting in the soil becoming malnourished and eroded. Therefore, an agricultural system is needed where it can be implemented on a small-scale land area but can produce entire crops and reduce land use in agricultural systems.

In addition, most crops use chemical fertilizers. Using fertilizers on plants is like an obligation in an agricultural system. Whereas according to R. Kumar &

Keshar Dev explained that using synthetic fertilizers in excessive quantities harms human health. It pollutes air, soil, and surface water and directly or indirectly affects human health. High levels of nitrates and nitrites in chemical fertilizers can cause several diseases. Some fertilizers contain heavy metals such as cadmium and chromium and high concentrations of radionuclides that cause respiratory and excretory diseases. Cadmium poisoning, derived from its excessive intake, can cause damage to the kidneys, bones, and lungs (Kumar and Dev, 2017). Therefore, natural fertilizer is needed for plants, one of which is derived from fish manure and fish feed residues that settle to the bottom of the fish pond. So here, farmers must be able to think about how to create sustainable circulation by combining fish farming and agriculture.

Technological advancement significantly affects an agricultural system, especially a traditional one, where traditional agricultural systems cannot control agricultural variables such as how much sunlight plants will receive, water pH, water temperature, and water ppm. In traditional agriculture, farmers also have to come manually to check the condition of the crops, which is a waste of time and energy. Therefore, the change from traditional agriculture to modern agriculture is urgently needed. Alare Kehinde explained that Smart Agriculture could find information about weather conditions, soil, diseases, insects, seeds, fertilizers, etc. (Kehinde et.al.,2021). Therefore, an agricultural system is needed to monitor the system in the agricultural system, either manually or through an application on a smartphone.

1.3 Objectives

The objectives of conducting this research include:

1. To design a vertical smart farming system embedded with Internet of things (IoT)
2. To implement a mobile surveillance system to provide the user with 24/7 monitoring

1.4 Scope of the Project

i. Designing a Vertical Farming embedded with an IoT system.

In this section, researchers design two aspects: vertical farming design and IoT system design. In designing vertical farming, researchers design how to integrate agriculture and fisheries in a vertical farming system to create mutually sustainable systems. The second is the design of the IoT system, which includes; making circuit diagram designs and designs on the smartphone application used.

ii. Create vertical farming embedded with an IoT system.

In this section, the researcher implements the designs that have been made before; As previously discussed, the manufacturing procedure will follow two aspects: creating vertical farming and creating an IoT system. In vertical farming manufacturing, the researcher prepares the tools and materials to be used, then does a project according to the design that was made before. Then in the section on making the IoT system, researchers buy tools and materials and then install and assemble the circuit according to what has been planned, not only that the researcher also makes and creates coding for the circuit that has been made along with the coding for the smartphone application used.

iii. Testing vertical farming embedded with an IoT system.

Then the last part is testing the vertical farm embedded with the IoT system so that researchers can find out if something is not working. Based on the explanation above, the test includes vertical farming and the IoT system. In testing vertical farming, the researchers carried out several tests, such as the strength of pipe and iron connections, the flow of the water cycle, the lighting used, pump cables, and others. In testing the IoT system, researchers tested the programming contained in the microcontroller, tested sensors, tested actuators, tested cable connections, and tested the applications used.

1.5 Significant of the Project

Because agriculture and fish farming are the leading sectors in Indonesia, these sectors can provide substantial income for the national economy. Agriculture and fish farming are managed not only by large industries but also by small and

medium-sized businesses. Even so, agricultural and fishery land at this time was getting smaller due to the high land expansion to construct industrial factories and other buildings. The reduction in agricultural and fishery land has decreased agricultural turnover, especially in vegetable and fish cultivation. The demand for vegetables continues to increase as the population increases and awareness of nutritional needs increases. If left unchecked, the price of vegetables will increase due to high demand but not be matched by the existing stock. Because prices increase and stocks run low, this can increase the price of other foods. Therefore, it will cause a lot of poverty and hunger everywhere. On the other hand, the production of vegetables has not been enough for market needs and demand because agricultural land is becoming increasingly scarce, and vegetable productivity is still relatively low.

Based on these issues and the "Sustainable Development Goals," researchers proposed vertical farming, which combines fish and vegetable cultivation. The vertical farming system is more effective for small and medium-sized industrial vegetable and fish farming systems because the capital required and the land area are smaller. Therefore, the problems and proposals of this researcher will answer SDG number 2 regarding "End hunger, achieve food security, improve nutrition, and promote sustainable agriculture."

Because the vertical farming technology system combines the aquaculture system and the hydroponic system, water resources are vital in an aquaculture system; the availability of water, both quantitatively and qualitatively, is a prerequisite for aquaculture activities. Especially in aquaculture, fish waste and uneaten fish food usually settle on the bottom of the pond, which can be toxic to the fish. Usually, the leftover food and fish waste will be sucked up using a water pump and thrown away, even though the aspirated water is also wasted during disposal. Along with the increasingly rapid rate of development, one of the consequences we face is the shrinking of water sources, especially in urban areas. Water, for example, can be used to support human daily activities.

Therefore, the problems faced and the researcher's proposals also answer SDG number 12 regarding "ensure sustainable consumption and production

patterns," because in the case of vertical farming, the dirt and leftover fish food will be filtered and absorbed by plants. The water contained in fish feces and food waste contains nutrients for plants, so when water containing fish waste and food waste enters hydroponics, the water from hydroponics can re-enter the fish pond, causing a symbolism of mutualism. Also, clean water will be added to the pool when there is a reduction, which could be caused by evaporation from the sun, and the worst thing is pool leakage.

However, applying technology in vertical farming needs to increase the efficiency of maintenance and control so that the productivity and quality results for vegetables and fish are as expected without directly controlling plants or fish. Therefore, innovation and technology are realized in manufacturing intelligent vertical farming systems based on the background and solutions for urban agricultural development. Therefore, researchers in this solution and proposal also answer SDG number 9 regarding "Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation."

1.6 Project Limitations

Several things limit the discussion of the problem in this study, including :

1. Because solar panels cost a lot and most of the sun is covered by clouds, the power supply is only from AC power sockets at home.
2. Not all plants can be grown using vertical farming; some cannot, such as long-lived plants, plants with tubers that require soil, or plants with large fruit