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To cite this article: D K P Aji *et al* 2021 *IOP Conf. Ser.: Mater. Sci. Eng.* **1073** 012030

IOP Conf. Series: Materials Science and Engineering 1073 (2021) 012030 doi:10.1088/1757-899X/1073/1/012030

Smart ecosystem for hydroponic land in the hydroponic farmers group guided by CSR PT. Otsuka Indonesia as an improved quality and quantity of harvest results

D K P Aji*, U Nurhasan, R Arianto and O D Triswidrananta

Department of Information Technology, State Polytechnic of Malang, Jalan Soekarno Hatta No.9, Jatimulyo, Kec. Lowokwaru, Kota Malang, Jawa Timur, Indonesia 65141

*deddy_kusbianto@polinema.ac.id

Abstract. Corporate Social Responsibility (CSR) is a community development program managed by PT. Otsuka Indonesia, one of which is form a hydroponic farmer community. In the activity of fostering hydroponic farmers there are several problems, namely the process of plant nursery, seeding, and harvesting are still carried out conventionally, while the assisted farmers do not have much time to supervise because they have a core job. Based on these problems, this study will focus on solving the problem of hydroponic plant supervision that can be known directly by farmers and also from the CSR of PT. Otsuka Indonesia. In completing the research, the steps carried out were based on the CRISP-DM (Cross Industry Standard Process for Data Mining) methodology. The factors used in solving the problem are the type of hydroponic plants, the acidity of the soil, the intensity of sunlight, the ambient temperature of the hydroponic plants, the water level and periodic reporting as needed in the form of a Smart Ecosystem. For this reason, it is necessary to build a device from an Arduino microcontroller based on IoT so that supervision of the hydroponic planting process can be done without having to be in hydroponic land and get reports every period of the development of hydroponic plants in the application. By using this device, it is hoped that many hydroponic farmers will use it so that during the hydroponic vegetable production process it can be in accordance with the old standards of the nursery until it is worth selling.

1. Introduction

Corporate Social Responsibility (CSR) or what is commonly referred to as Social and Environmental Responsibility (TJSL) has been regulated in Article 1 Number 3 of Law Number 40 of 2007 concerning Limited Liability Companies (Government of the Republic of Indonesia, 2007) describes the company's commitment to participate in sustainable economic development in order to improve the quality of life and a beneficial environment, both for the company itself, the local community, and society in general [1].

To fulfill the obligations of the PT Law, PT. Otsuka Indonesia makes CSR activities including: (1) Public Health (Sehat with Otsuka), (2) Community Environment (Go Green with Otsuka), (3) Community Education (Smart together with Otsuka), and (4) Disaster Nature (Rise Together with Otsuka). These CSR activities began in 2008. One of the activities of the Community Environment program (Go Green with Otsuka) is to form a hydroponic farmer community under the guidance of PT.

IOP Conf. Series: Materials Science and Engineering 1073 (2021) 012030 doi:10.1088/1757-899X/1073/1/012030

Otsuka Indonesia is located in Kalirejo Village, Lawang District, East Java, as many as 7 RTs from RW 04 and RW 08.

With the development of the hydroponic farming community, several problems have begun to emerge, including: market needs for hydroponic vegetables in the Lawang Market, and managing hydroponic plants that have low quality so that they only become waste for farmers.

Based on some of these problems, research in this first year will focus on solving the problem of hydroponic plant supervision that can be known directly by farmers and also from the CSR of PT. Otsuka Indonesia. The factors used in solving the problem are the type of hydroponic plants, the acidity of the soil, the intensity of sunlight, the ambient temperature of the hydroponic plants, the water level and reporting to CSR for a certain period according to needs in the form of a Smart Ecosystem. Because hydroponic farmers who are assisted by CSR PT. Otsuka Indonesia's number continues to grow, so a special hydroponic microcontroller will be built. By using a cheap microcontroller, namely using Arduino compared to using the Raspberry Pi, it is hoped that many hydroponic farmers will be interested in using it so that during the hydroponic vegetable production process it can match the old standards of the nursery until it is worth selling and the CSR of PT. Otsuka Indonesia can determine what steps to take if there is hydroponic land that does not comply with the standard.

Internet of Things, also known as IoT, is a concept that aims to expand the benefits of continuously connected internet connectivity. IoT is a concept that uses the internet as the main infrastructure network that connects certain objects [2]. As for abilities such as data sharing, remote control, and so on, including objects in the real world. For example foodstuffs, electronics, collections, any equipment, including living things which are all connected to local and global networks through embedded sensors and are always active [3]. The development of IoT for automation has been developed in various fields, in agriculture, for example. Lan-Da Van, et al. In 2019 developed a mobile-based application to monitor plant growth [4]. In this study, it was proven that an artificial intelligence could be implanted in a monitoring application to support proper analysis related to plant growth. In another study conducted by usman, et al. In 2018. That the IoT concept can also be applied to hydroponic agriculture [5]. This research focuses on controlling water circulation in hydroponic growing media of the DFT (Deep Flow Technique) type. As reinforcement of the basic research is the results of research conducted by Carlos Cambra, 2018 entitled "Smart System for Bicarbonate Control in Irrigation for Hydroponic Precision Farming [6]. In this study, Cambra monitored the availability of bicarbonate nutrients in the DFT type hydroponic growing medium.

2. Method

In completing the research, the steps were carried out based on the CRISP-DM methodology in the Figure 1 below:

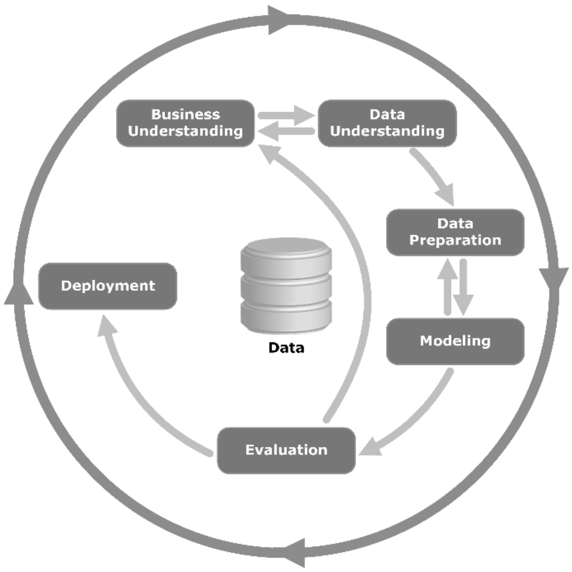

Figure 1. CRISP-DM (*Cross – Industry Standard Process for Data Mining* [7].

In 1999, sizable companies included automaker Daimler-Benz, insurance provider OHRA, hardware and software manufacturer NCR Corp and maker of statistical software SPSS, Inc. began working together to formalize and standardize approaches to data mining [8]. The result of their work is CRISP-DM, the Cross-Industry Standard Procedure for Data Mining which contains 6 stages, namely:

2.1. Business understanding
At this stage, an understanding of the ongoing business processes will be carried out. Where, to obtain this information, an interview process with the CSR PT. Otsuka Indonesia and visit the hydroponic farmer area directly so that they will get an accurate understanding of the ongoing business processes and the problems faced by the assisted farmers.

2.2. Data understanding
By knowing the problems faced by hydroponic farmers assisted by PT. Otsuka Indonesia, data will be collected which will be needed to develop solutions that can be offered, whether the data taken from the CSR of PT. Otsuka Indonesia, hydroponic farmers, and what kind of output from the system are needed by both parties so that it can become a solution that is right on target.

2.3. Data preparation
The data that has been collected will be carried out equalization or alignment both in terms of data type, data format, or deletion of data in a process so that the data used for the next stage is really the data needed and is ready to be processed.

2.4. Modelling
At this stage, modeling will be carried out from the data that has been prepared by determining the type of modeling that matches the existing data criteria. The modeling used later must have a low error rate and not have a long work process because the model will be applied to smartphones and the IoT.

2.5. Evaluation
The evaluation stage is to evaluate the modeling that has been carried out before it is implemented on the research object. At this stage, an evaluation will be carried out by building a prototype in accordance with the conditions in the field so that any mistakes can be found and can be corrected as soon as possible.

2.6. Deployment
At this stage, a prototype will be implemented that has been evaluated on the object of research with the actual situation in the community and training will be carried out for the use of tools, monitoring of tools, and maintenance of tools for a certain period of time.

3. Implementation
The water circulation monitoring and control system that was built aims to provide convenience to hydroponic activists in monitoring and controlling hydroponics. The initial process carried out by the system is that the sensor is placed on hydroponics to detect the value of the sensor data in accordance with the parameters needed for hydroponic mustard plants. After getting data from sensors such as temperature, humidity, pH and height of the reservoir water, it will be stored in a database and displayed on the website as the output of the monitoring process. Then the sensor data that has been obtained will be processed to determine the process of controlling the hydroponic water circulation. In this control process, the data used are temperature and humidity which will be processed using the Sugeno fuzzy method in determining the right time to flow hydroponic water. The figure 2 is the design of the tools used.

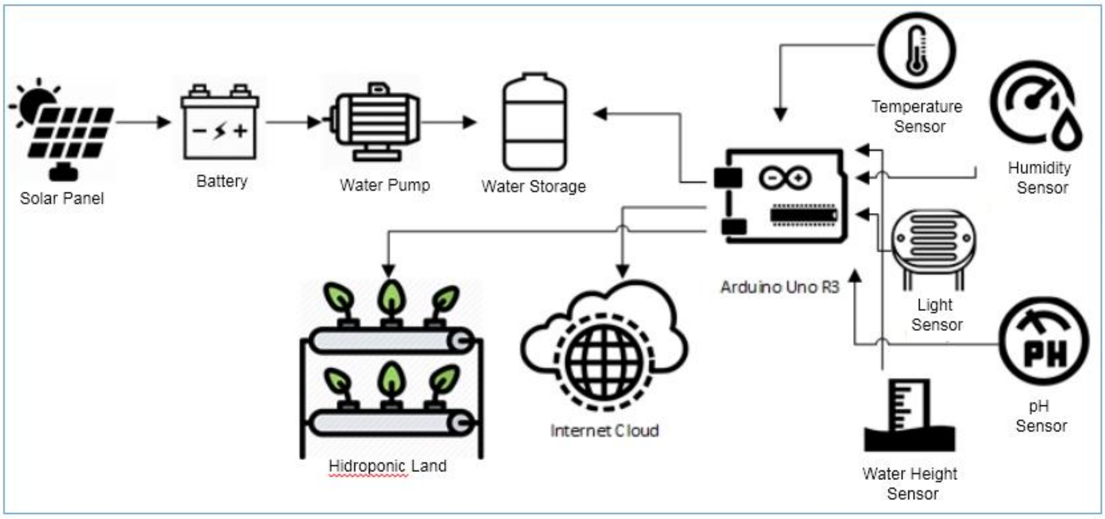

Figure 2. Device design.

Table 1. Device specifications.

Object	Information
Solar Panel	Polycrystal 100 Wp
Battery	Min. 12 Volt / 12 Ah
Water Pump	DC 12 Volt, 50 - 70 Liter / minute, Maximum height 4 - 5m, 5500 - 5800 rpm
Water Storage	Size 70-120 liters with a maximum height of 800 mm
Microcontroller	Arduino Uno R3, Temperature Sensor, Humidity Sensor, Light Sensor, pH Sensor, Water Height Sensor
Hidroponic Land	Land size between 80-100 holes, Spinach and PakChoy plant types, Height of 1 - 5 meters, Pipe size 2 "
Internet Cloud	Use the free version (ThinkSpeak)

In the figure 3, the monitoring and controlling system for hydroponic water circulation begins by taking values from several sensors. All sensor data that has been obtained is entered into the database. Temperature and humidity data will be used in the fuzzy process, then the system will turn on the water

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pump and turn off the water pump automatically according to the final result of the fuzzy calculation process. The results of data collection from several sensors will be displayed on the website as a parameter for monitoring plant growth elements in hydroponics. In addition, the fuzzy calculation results are also displayed along with the existing pump conditions. The following is the workflow of a fully automatic hydroponic water circulation control system using the fuzzy method:

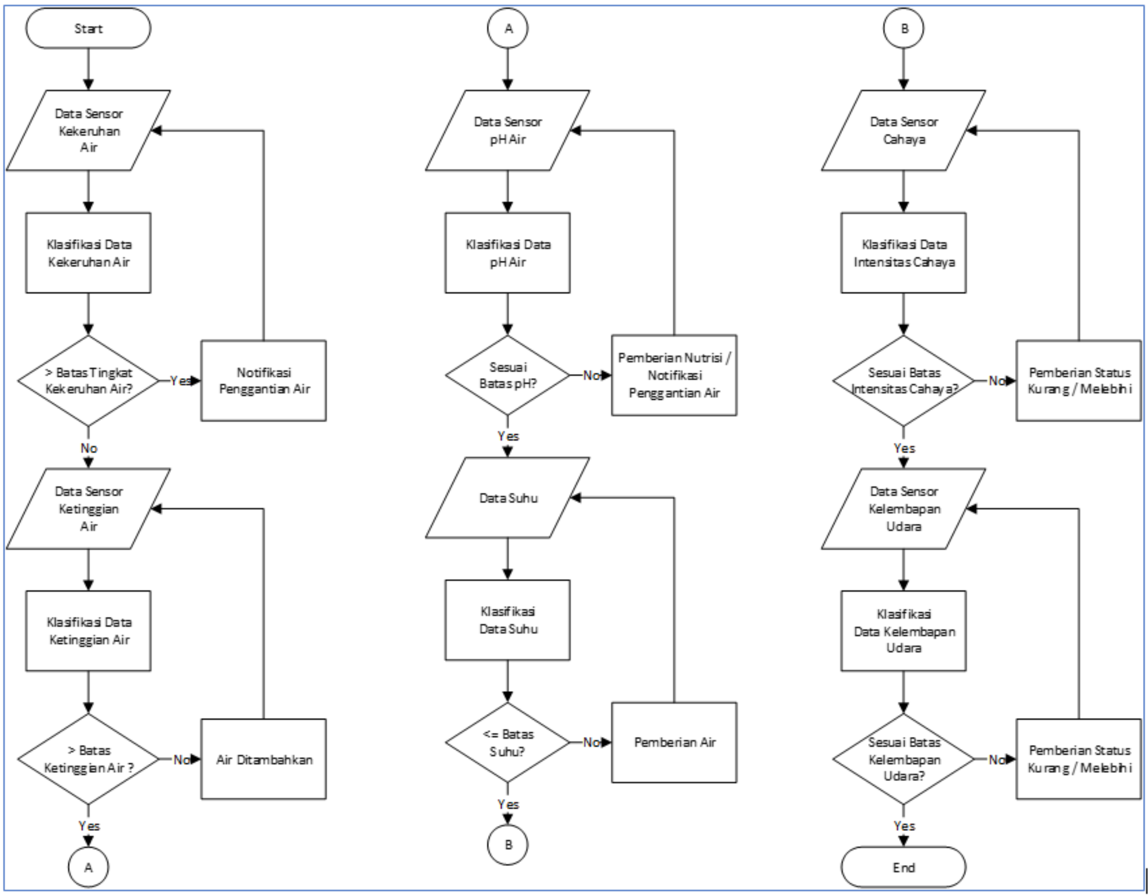

Figure 3. Fuzzy flowchart on device.

The method applied to the system of monitoring and controlling water circulation in hydroponic mustard is the Fuzzy method. The steps in calculating the fuzzy method are the first, determining the crisp value or the firm value of the values obtained by the sensor in the form of temperature and humidity values. At the fuzzification stage a membership function is obtained. Then perform the fuzzy logic operation and its implication in the form of a min function, and determine the output in defuzzification [9]. Here is a rule based on fuzzy logic.

3.1. Data obtained from the water turbidity sensor

- Starting from 4.5 - 4.58 Volts, the notification to the user is "Very Turbid" and gives a status of "Very Turbid“
- If 4.59 - 4.64 Volt, the notification to the user "Turbid" and gives the status "Turbid“
- If the result is more than equal to (≥) 4.65 Volts it will give a status of "Clean"

3.2. Data from the water level sensor in the Water Storage Container

- The water level between 0 - 350 mm will fill the water and give the status of "very less water".
- The water level between 351 - 749 mm will fill the water and give the status "Water less".

IOP Conf. Series: Materials Science and Engineering 1073 (2021) 012030 doi:10.1088/1757-899X/1073/1/012030

- The water level is more than 750 mm, it will give a status of "enough water" and stop water filling.

3.3. Data obtained from the water pH sensor
- Shows less than 6.0, the notification "Change Water" will appear.
- Showing more than 7.0, the notification "Add Nutrition" will appear.
- Showing between 6.0 - 7.0, it will give a notification "Normal"

3.4. Data obtained from the temperature sensor
- Shows less than 16 ° C will give the status "Cold temperature"
- Shows more than 20 ° C it will give a status of "Heat Temperature" and will turn on the water pump to drain the water.
- Showing between 16 - 20 ° C will give the status "Normal Temperature"

3.5. Data obtained from the light intensity sensor
- Showing less than 32 Lux will give you the status of "Lack of Light"
- Showing more than 108 Lux will give you the status of "Excess Light"
- Showing between 32 - 108 Lux will give you the status of "Normal Light"

3.6. Data obtained from the Air Humidity sensor
- Shows less than 40% it will give the status "Humidity Less"
- Shows more than 60% it will give the status "Excess Humidity"
- Shows between 40 - 60% it will give the status "Normal Humidity"

4. Conclusion
The results of the sensor data can control the circulation of water using a pump in hydroponics in accordance with a system that has been previously designed. Then the ultrasonic proximity sensor that is used to detect the height of the water in the pipe and reservoir can also run well can automatically start the pump when the water level in the pipe is less than 3 cm.

This research has succeeded in making a system that is used for monitoring and controlling the circulation of mustard hydroponic water using a water pump automatically with fuzzy logic through a smartphone interface.

Based on observations on the growth of mustard plants which were compared between using a monitoring system and controlling water circulation by not using the system, resulting in a significant difference in height growth results and number of leaves.

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