# Office Environment Warning System

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**Abstract**

Humidity, dust, sun-UV are some factors that we face in our daily life. Although we keep ourselves to work or live in a room or an office. How do we actually know if it is safe or not? It may have some dust within our place. It may have sun-UV coming through the window. Or humidity level is too wet or too dry. It will cause problems for our health if we live with those environments in the long term. So we decided to create a device that measures those factors (Humidity, dust, and sun-UV) in our living space. The device was made similar to a small box. It composed of ESP-32, a dust sensor, a humidity sensor, and a sun-UV sensor. It can measure all indicators and display them via mobile application modified from MIT app inventor. If the value is not normal, the suggestion will be provided for the user on the mobile application. We tested our system with three different sections, dust section, sun-UV section, and humidity section. Each section shows us some factors that may affect the changing of those environments. It can accurately measure a small area. It was only created for us to know that the environment around us is good enough to work or live for the long term.

**Keywords:** Dust, Sun-UV, Humidity, IoTs, MIT app inventor

## Introduction

The environment in our office is the key factor that makes us work smoothly. Sometimes we may not notice by eye or not be able to feel it at all. Even though we will notice that the outside has so much dust and the sun-UV. But inside our office, we may not notice all of those clearly. Therefore, if we work or live in a dirty room for a long time, it may cause us many health problems such as allergies, difficulty in breathing or possibly skin cancer.

At present, there are numerous devices used in detecting the surrounding area. IQAir Monitor (AirVisual Pro, n.d.) is one of the well-known devices that provide user with air-quality knowledge and forecasting. It can present real-time air quality both indoor and outdoor on an LED screen. It works perfectly when it connected to Wi-Fi. But there are some limitations on IQAir Monitor such as its cost and the ability to measure the sun-UV. SW-825 Air Quality meter (MaxMac, 2019) used to detect PM2.5 concentrations in both indoor and outdoor. It is suitable for use in house, office and everywhere else. SW-825 is designed to be carried everywhere. But it can measure only PM2.5 concentrations.

However, there is some research about the monitoring device. IoT based Smart Water Tank with Android Application (Theja, 2018) this project can monitor and control the level of water in the tank. It based on IoT and android application. Low-cost automated weather station (Mohamad, Mohammaed, Mohammed, & Abdelbaset, 2017) the low-cost station is designed to report weather around it such as humidity, temperature or wind speed. It provided for user via blynk and LCD screen. But the station is difficult to carry with the user.

Therefore we decided to create a portable device for measuring the humidity value, sun-UV value, and dust value, and then display them on the mobile application. We used the MIT app inventor to build this android application (Xi & Patton, 2018). Those above values will be presented real time along with their levels on the mobile application interface. Some suggestions are provided in the mobile application in case that device measures the critical values. This device is portable. User can use it indoor and outdoor. Users can carry it to hospitals, government agency or anywhere else where the area has crowded. Because the public area may have a lot of dust. We created this system to let the users to be aware of the quality of the environment around them.

This paper is structured as follows. Section 2 describes the proposed algorithm and some details of the materials. The results and conclusion will be in sections 3 and 4 respectively.

## Methodology

### 1. Circuit diagram

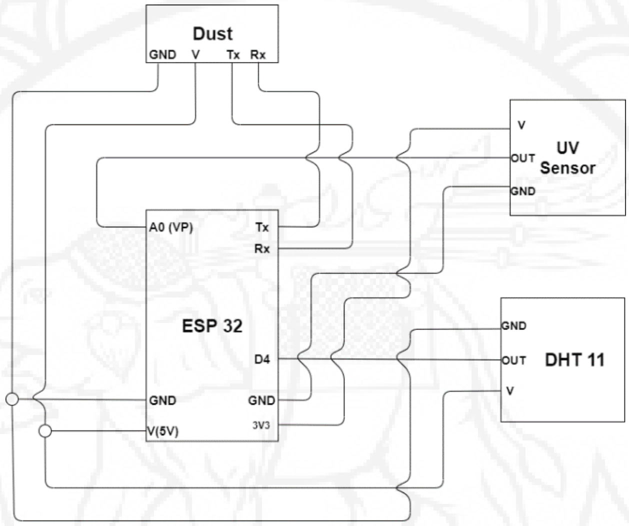


**Figure 1** Circuit diagram

Figure 1 shows the circuit diagram of our device. It consists of three sensors and one micro-controller. The name and characteristics of each component that we chose in our project will be described below.

*ESP-32 module:* ESP-32 is designed as a single chip 2.4 GHz. It can connect to Wi-Fi and Bluetooth. It can make the most effective use for best power performance. We use ESP-32 as a micro-controller for activating the sensor to detect the value and send the value to the database via Wi-Fi.

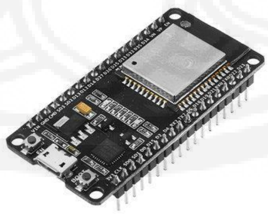

**Figure 2** ESP-32 module

*UVM-30A module:* UVM-30A is designed to measure the sun-UV index. It can accurately measure the sun-UV so we use it for the sun-UV sensor in our project.

**Figure 3** UVM-30A UV sensor module

*DHT-11 module:* DHT11 is designed to be a module that can measure both temperature and humidity. This module consists of the humidity sensor and thermistor so it can measure both at the same time. It's fairly simple to use but it requires careful timing to collect data. It can easily find it so we decided to use this module for measuring humidity.

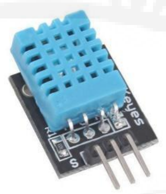

**Figure 4** DHT-11 sensor module

*PMS-3003 module:* PMS-3003 is a digital particle concentration sensor. It can be used to obtain the number of suspended particles in the air. There are two options for digital output: active and passive. Default mode is active after power up. In this mode, sensor would serial data to the host automatically. So we decided to use this module for measuring the dust value.

**Figure 5** PMS-3003 sensor module.

**2. Block Diagram**

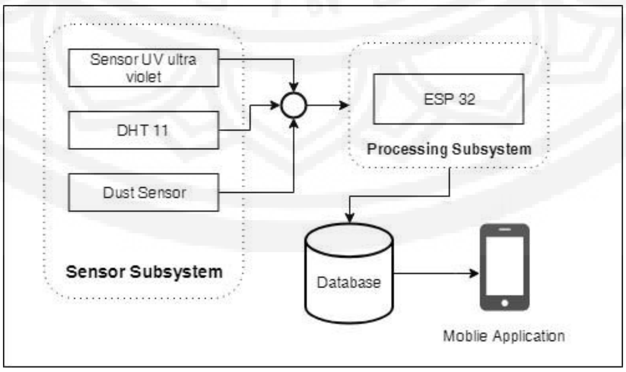


**Figure 6** Block Diagram

The block diagram is shown in Figure 6. ESP-32 which is a processing subsystem connects to the sensor subsystem which consists of UVM-30A (Sun-UV sensor), DHT-11 (Humidity sensor) and PMS-3003 (Dust sensor). ESP-32 will activate the sensors and collect data from them. Then ESP-32 will send the collected data to the database and mobile application will take the data from the database to display them on it via Wi-Fi.

For the database platform, we decided to use the Firebase. Firebase is a database platform that can build the table to collect the data from a microcontroller or anywhere else. It also reduces the time and cost of making the server-side.

**3. Flowchart**

The system flowchart, UV sensor flowchart, humidity sensor flowchart and the dust sensor flowchart are presented in Figure 7, 8, 10, 11 respectively.

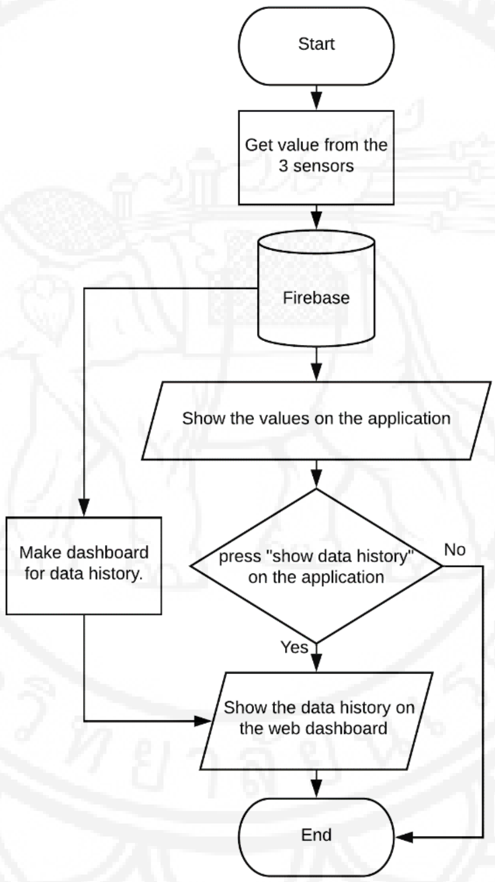


**Figure 7** System Flowchart

The sun-UV value that we used as a reference in the UV sensor flowchart in Figure 8 is from the Ultraviolet Index (UV Index). The UV Index is the measurement of international standard in the matter of the sun burning by ultraviolet radiation (The UV Index (and Why You Should Care About It), 2019). The level of the Ultraviolet Index is shown in Figure 9. In our system, we set the value as "Normal" for UV Index $\leq 2$. We set the value as "Bad" for $3 \leq$ UV Index $\leq 7$. And we set the value as "Very bad" for UV Index $\geq 8$.

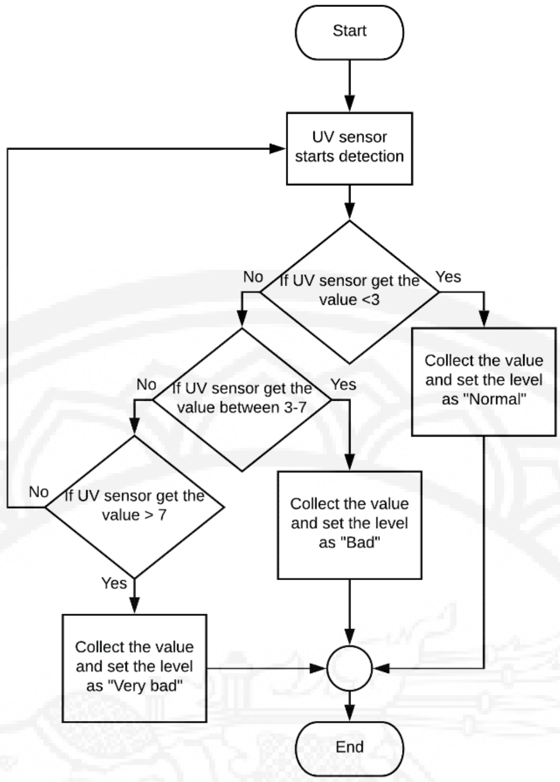


**Figure 8** UV Sensor Flowchart

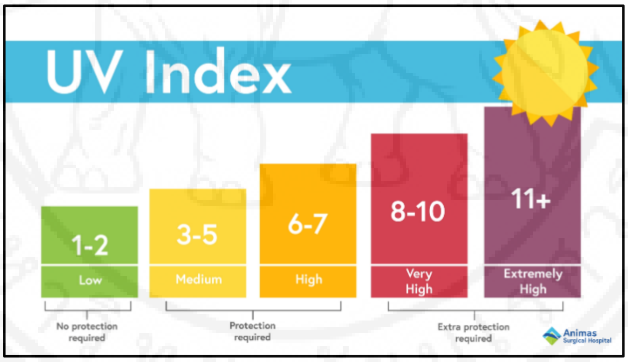


**Figure 9** Ultraviolet Index (The UV Index (and Why You Should Care About It), 2019)

The reference humidity value that we use to make the decision in Figure 10. Humidity levels should range between 30 and 60 percent (Leanne, 2016). If the humidity value is between 30 and 60 percent, it means the surrounding air is normal. If humidity value is lower than 30 percent, it means the surrounding air is too dry. If humidity value is higher than 60 percent, it means the surrounding air is too wet.

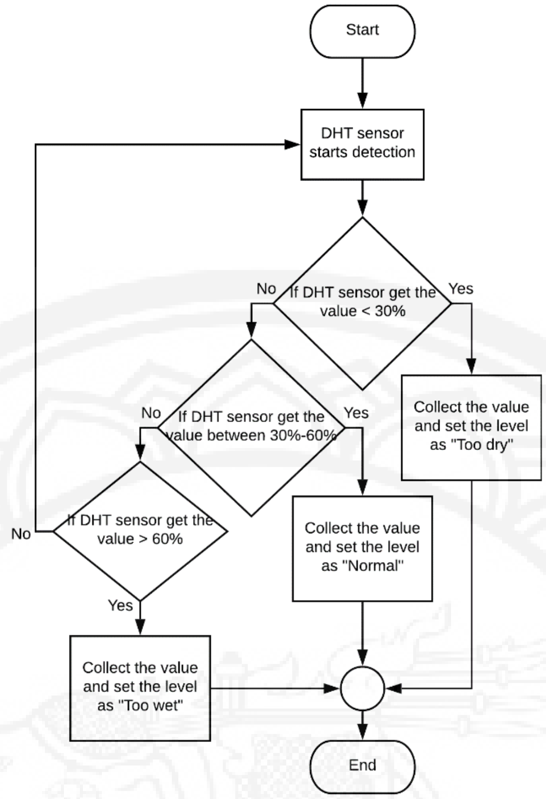


**Figure 10** Humidity Sensor Flowchart

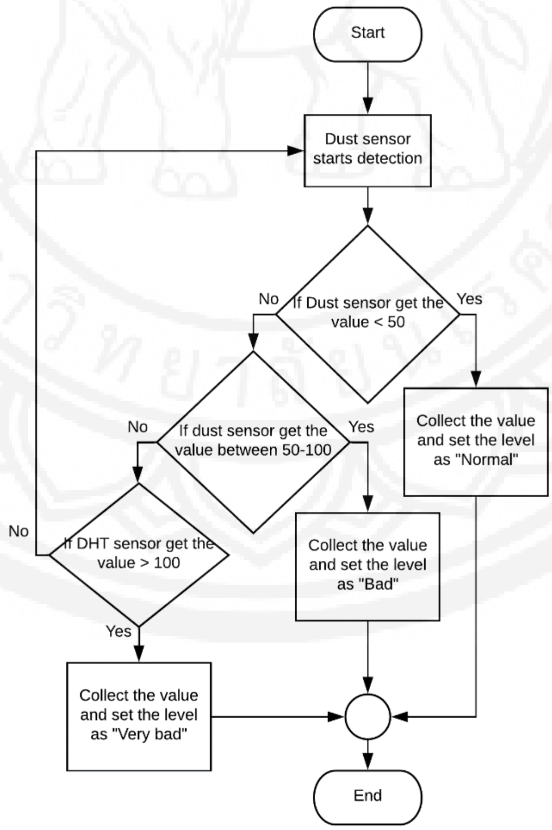


**Figure 11** Dust Sensor Flowchart

The dust value that we reference in the dust sensor flowchart is from the Air Quality Index (AQI) (Air Quality Information for the Sacramento Region, n.d.) The AQI is the report about air quality that the general public can easily understand. The level of AQI is shown in Figure 12. In our system, we set the value as "Normal" for the Index < 50. We set the value as "Bad" for 50 ≤ Index ≤ 100. And we set the value as "Very bad" for Index >100.

| Air Quality Index - Particulate Matter | |
|---|---|
| 301–500 | Hazardous |
| 201–300 | Very Unhealthy |
| 151–200 | Unhealthy |
| 101–150 | Unhealthy for Sensitive Groups |
| 51–100 | Moderate |
| 0–50 | Good |

**Figure 12** Air Quality Index (Air Quality Information for the Sacramento Region, n.d.)

**4. Model**

We designed a device similar to a small box by the size of 70x70x60 mm as shown in Figure 13. All elements such as a microcontroller (ESP-32), a dust sensor, a humidity sensor, and a sun-UV sensor are placed in that box. We set the sun-UV sensor on top of the model so it can measure the light directly. For the humidity and dust sensors, we set them at the bottom of the model. We created it as a small box because we want it to be a portable device and can put it on our working table or our living area.

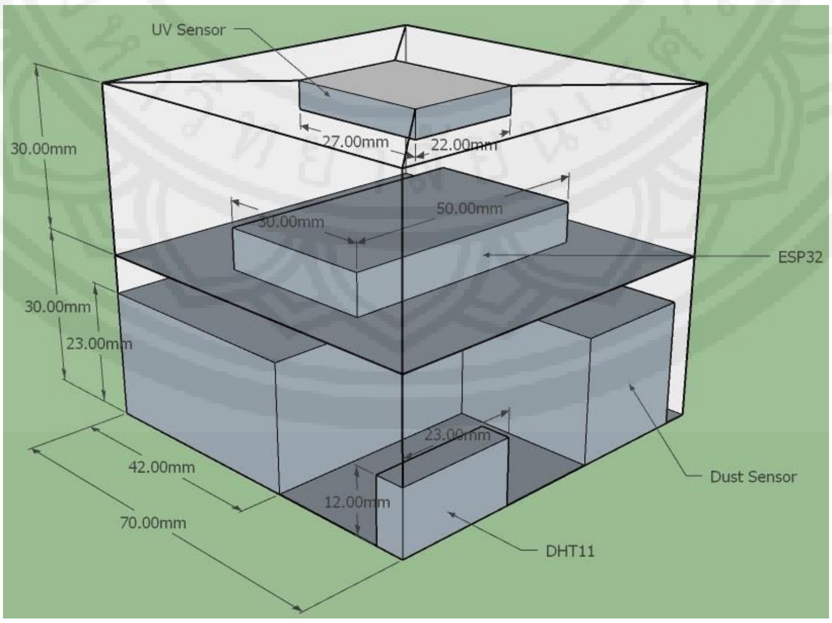


**Figure 13** Model

**5. User Interface**

We created a mobile application by using the MIT app inventor. MIT App Inventor is visual programming that allows everyone to build a mobile application for Android smartphones and tablets. We use this because it is easy to create the mobile application and connect easily to the Firebase. The user interface as shown in Figure 14 displays the value, level, and suggestion of each factor.

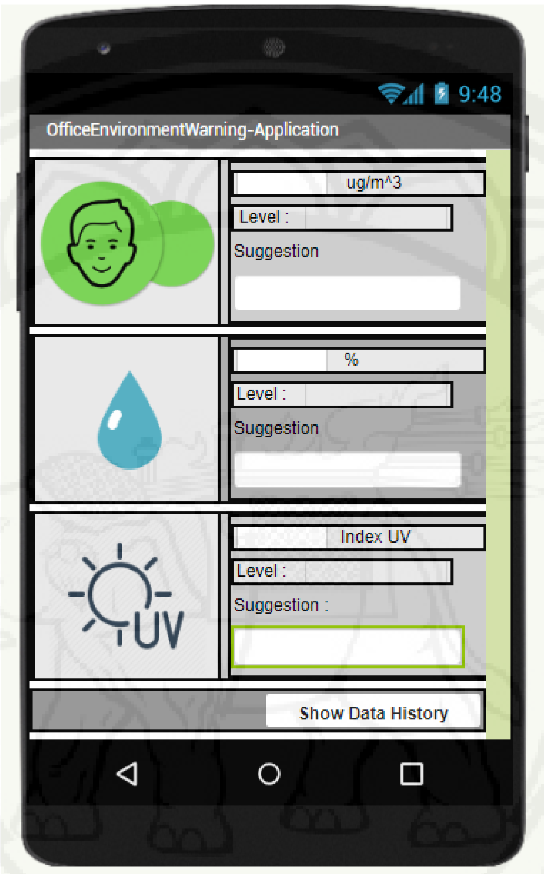


**Figure 14** Example of UI

For the value, we get it from the Firebase that stores the collected data from ESP-32. But the level and the suggestion, we write the code in-app inventor to make the decision to show on the user interface.

## Result

**1. Model**

The created model is made by an Acrylic sheet as shown in Figure 15. The Acrylic sheet weight is suitable for building this portable device.

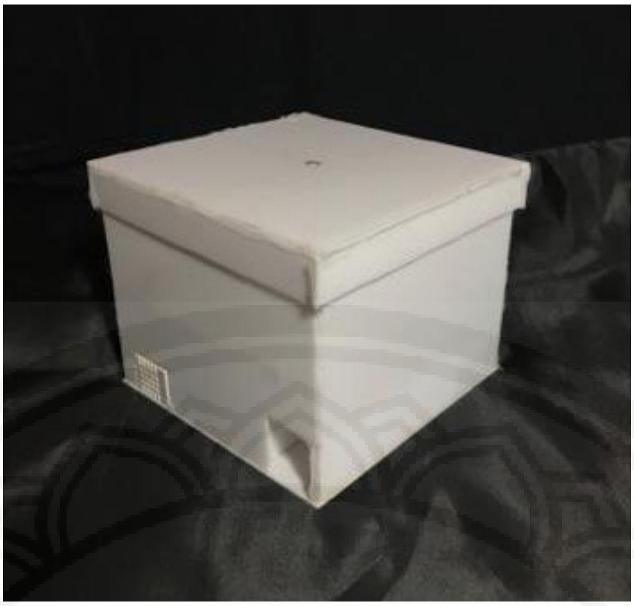

**Figure 15** Side view of the model

If something goes wrong with the device, you can open the top lid as shown in Figure 16 to see and fix the components in the box.

**Figure 16** Top view of the model

**2. User Interface**

Mobile application has two- screen; cover screen and main screen. For the cover screen, as shown in Figure 17, it only shows the application name. If you want to go to the main screen, you must tab at the “CLICK TO START”.


**Figure 17** Cover screen

For the main screen, as shown in Figure 18, it has 3 sections, dust section, humidity section, and sun-UV section. Each section shows the value at that time, level and suggestion. If you press at the "Show Data History", it will link you to our web dashboard as shown in Figures 19 and 20 that show the data history of each section.

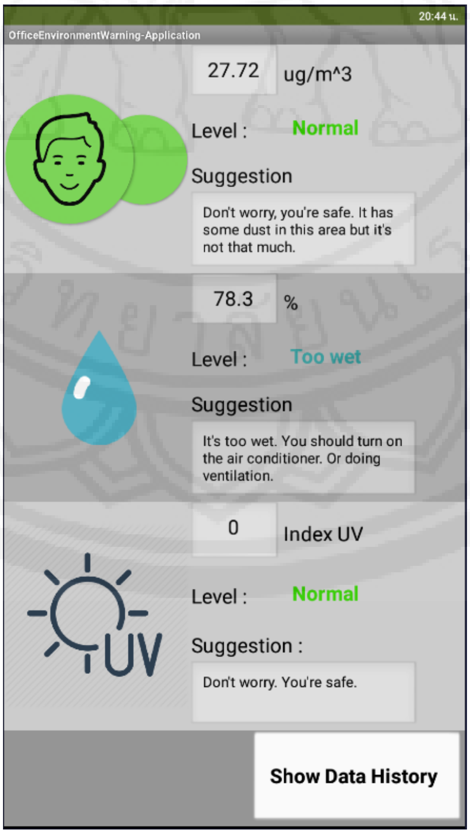


**Figure 18** Main Screen

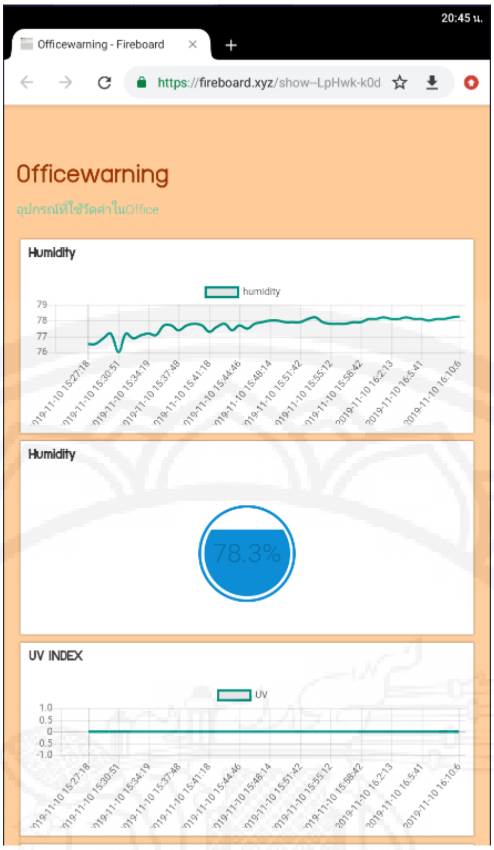


**Figure 19** Web Dashboard

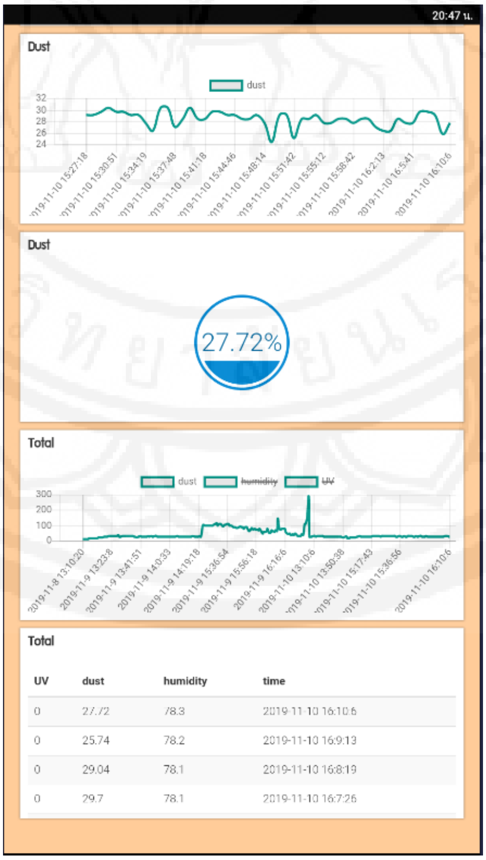


**Figure 20** Web Dashboard

For the web dashboard, users can scroll down to see all the data history of each value.

**3. Experiment**

The proposed system was experimented into three sections; dust section, sun-UV section, and humidity section.

*Dust section:* We designed the experiment by testing the device in two different places.

- **Place 1:** A room has a size of 4×4.5×3 m. Close area.
- **Place 2:** A room has a size of 5×10×3 m. Close area.

We tested it in different size of the room because we want to know that the size of the room affects the amount of dust or not. We set the place as the independent variable. So we must set all the pieces of stuff within place 1 to be similar to place 2. Both places 1 and place 2 are the close area. Anything from outside will not come inside those places. And they have a few furniture. Then we put the device in the center of the room and record the results. The result is shown in Figure 21.

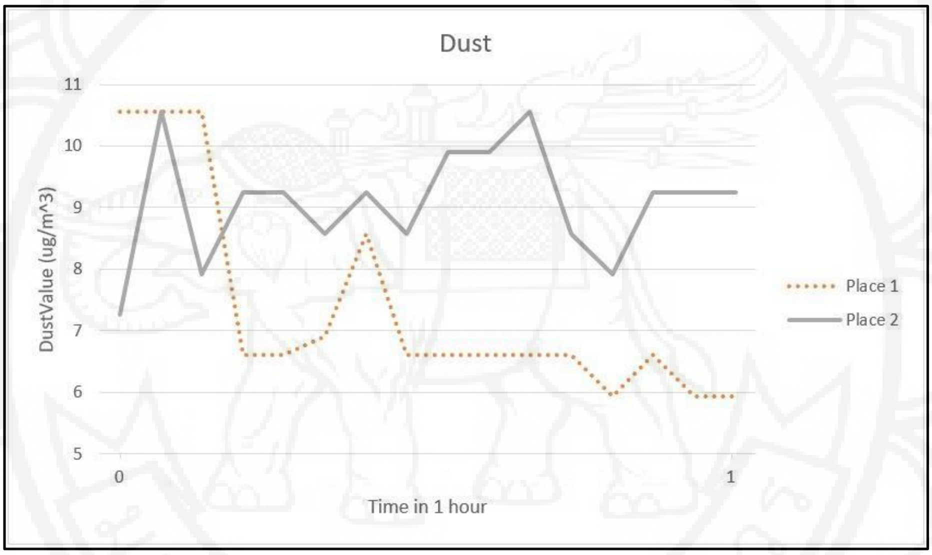


**Figure 21** Dust section result

From the result, as shown in Figure 21, we see that the dust value in place 2 is more than place 1. If we consider only the size of the room, it means the large room has the amount of dust more than the small room.

*Sun-UV section:* We've designed the experiment by testing the device outdoors in the morning and afternoon. Because we want to know that the sunlight in different period effect to the sun-UV index or not. The result is shown in Figure 22.

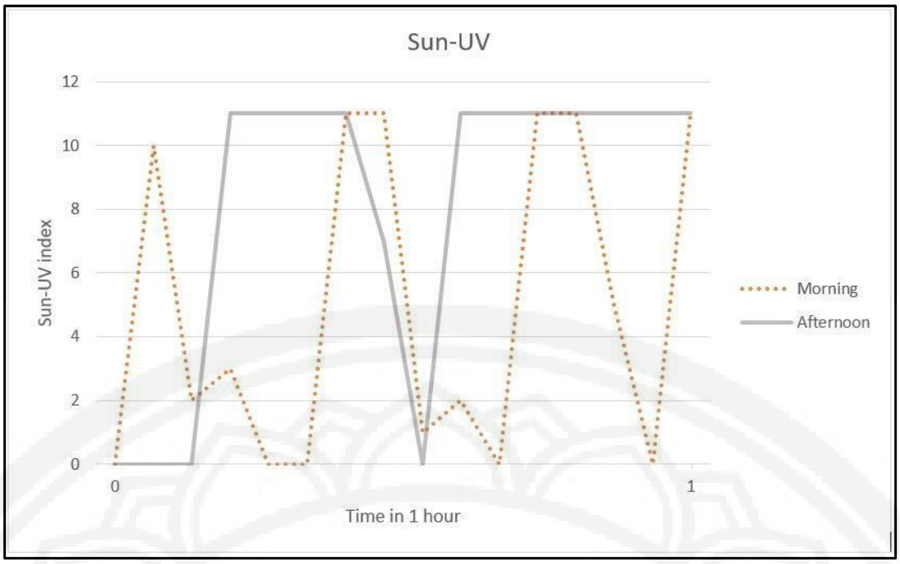


**Figure 22** Sun-UV section result

From figure 22, we conclude that the period isn't the main variable affected by the sun-UV index. Even if it has a high sun-UV index in the morning. It also has a high sun-UV index in the afternoon.

*Humidity section:* We've designed the experiment by testing the device in the daytime and nighttime. We want to know that different period affects the humidity or not? So we tested the device in place 1 from the dust section. The result is shown in Figure 23.

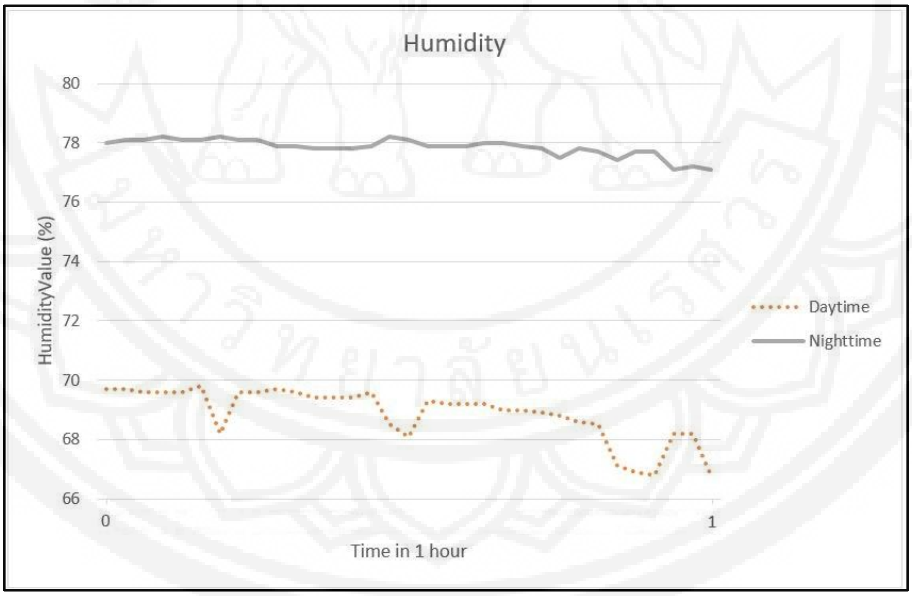


**Figure 23** Humidity section result

From Figure 23, we conclude that the humidity in the daytime is lower than in the nighttime.

**4. Survey**

We have shown our work to our target users and ask them to complete the survey about UI application. In our survey, we have 4 questions:

- How difficult was it to use this application? Scale 1-5 : very easy - very bad
- How about the suggestion shown in the application? Scale 1-5 : very bad - very good
- How about our web dashboard? Scale 1-5 : very bad - very good
- Do you think this application is helpful to make people care about the environment around them? : Yes or No

We created the survey by using Google Forms and the summary of our survey has shown below.

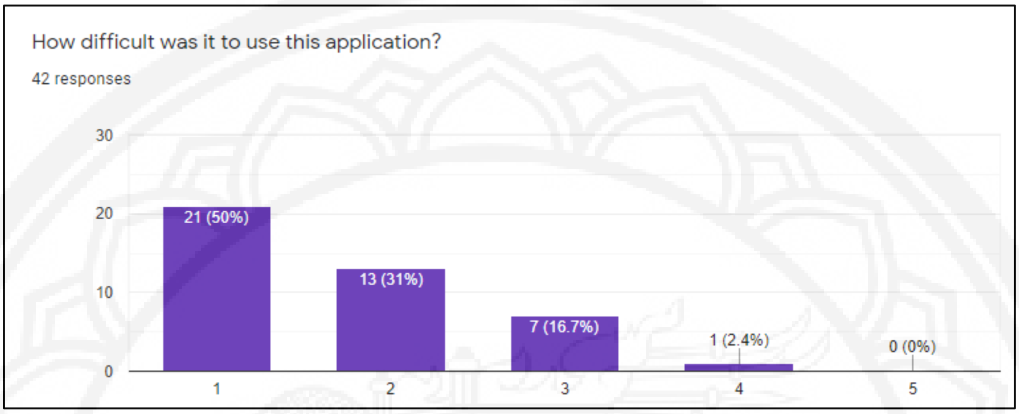


**Figure 24** Summary of question 1

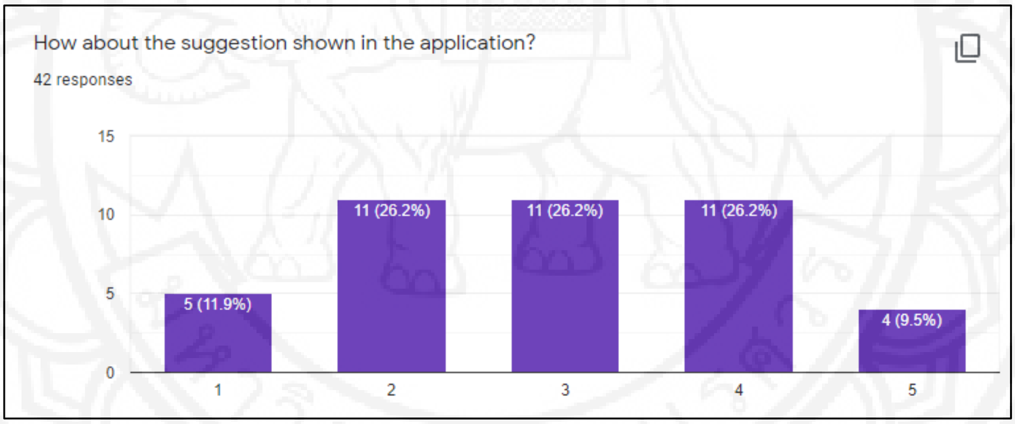


**Figure 25** Summary of question 2

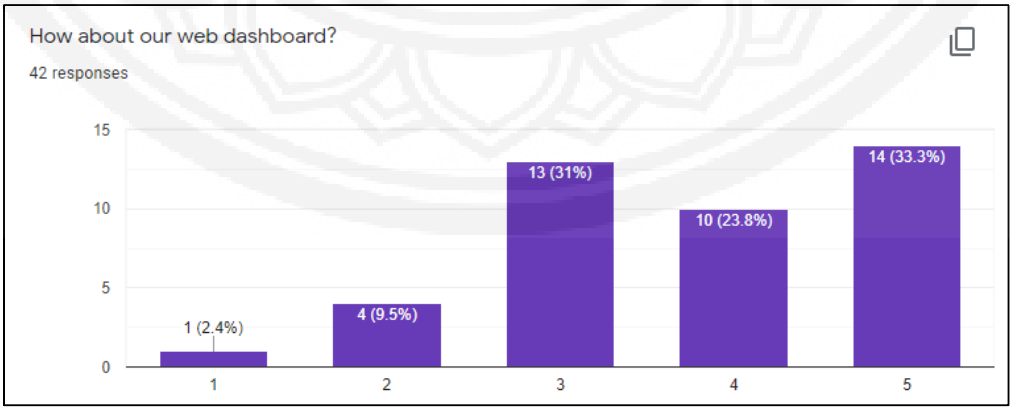


**Figure 26** Summary of question 3

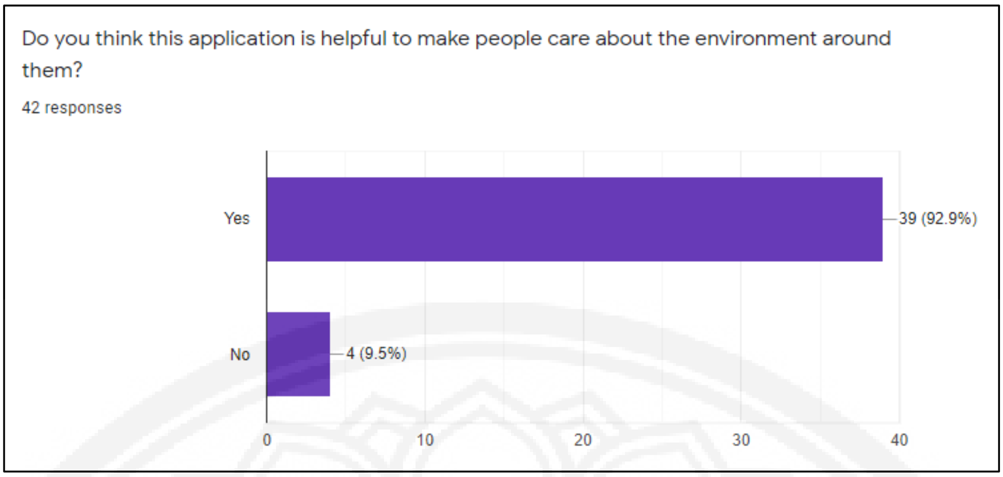


**Figure 27** Summary of question 4

From the summary of the survey, we conclude that our application is very easy to use and it is helpful to make people care about the environment around them. Our web dashboard is quite normal but our suggestion on the UI application isn't good. We will use this information in developing UI mobile application.

## Conclusion

From the experimental results, we conclude that the large room has more dust than the small room. The time affects the humidity. But time does not affect the sun-UV index. While we were testing in the sun-UV section, we noticed that the intensity of the sunlight affected the sun-UV index. More intensity sunlight has a more sun-UV index than less intensity. We have tried to demonstrate that some factors affect the changing of those environments. When we knew what factors affect the changing of the environments, we would be aware of them. We are more careful about our living space.

By the way, we suggest using this device in a small area. Any area has a size similar to place 1 for more accurate detection.

## Acknowledgment

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