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Studying the Temperature and Humidity of the Environment to Determine the Best Location for the Swimming Pool with BME280 and ESP32

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Abstract: The typical daily pool moisture content amounts to approximately a quarter of an inch, with an accumulation of over two inches within a week. This phenomenon can be attributed to the elevation in temperature and humidity within the pool area, triggered by an increase in swimming activity. As more individuals engage in swimming, both the water temperature and the overall ambient temperature rise, thereby expediting the evaporation of pool water. One of the key determinants of water evaporation is its temperature, which varies between indoor and outdoor pools. This paper delves into an analysis of the ambient temperature and humidity to identify the optimal location for a swimming pool, leveraging the BME280, ESP32, and Favoriot dashboard platform. The findings illustrate that the utilization of the BME280 sensor can effectively establish the most suitable swimming pool condition based on environmental temperature and humidity. The data gathered suggests that indoor pools are a preferred choice, given their ability to shield against the erratic outdoor conditions, thereby ensuring a more consistent temperature.

Keywords: *monitoring system, internet of things, microcontroller, sensor, favoriot*

1.0 INTRODUCTION

The average rate of pool water evaporation stands at roughly a quarter of an inch per day or over two inches per week. For a standard 10m x 5.5m swimming pool (representative of average pool size), this translates to more than 2,500 liters or approximately 600 gallons of water lost each week. It's important to note that this rate can vary significantly depending on your climate and various influencing factors[1].

Figure 1: 33ft x 18ft Oval Swimming Pool

The analysis indicates that with an increase in attendance, both the Predicted Mean Vote (PMV) and the average temperature also increase.

space rises as more people swim, accelerating the evaporation of pool water[2].

A contributing factor to water evaporation is water temperature, which differs between indoor and outdoor pools. The elevated indoor relative humidity results from evaporation and necessitates effective management to ensure a comfortable indoor environment for both the building and its occupants. The task of calculating the evaporation rate is tackled by building performance simulation (BPS) tools, employing diverse methodologies and formulas.

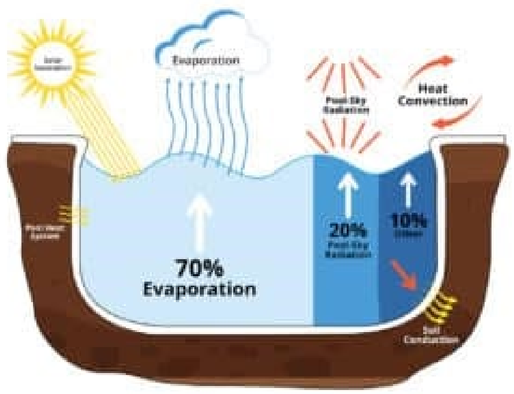


Figure 2: Pool Evaporation Rate

The higher physical activity factor between occupied and unoccupied pools represents the increased air-water contact area due to waves, ripples, and mist. This phenomenon also escalates with higher occupant density and activity levels. Regardless of the circumstances, the analysis yielded nearly equal results [3].

Numerous studies have investigated the environmental factors of temperature and humidity. Maté Bernhard et al. conducted a sensitivity analysis of an outdoor swimming pool under dynamic conditions using sophisticated mathematical modeling, experimentation, and simulation. The outcomes consistently demonstrated values that were almost comparable across all scenarios [4].

This paper aims to achieve the following objectives:

1. To determine the preferable pool type, indoor or outdoor, particularly for campuses where student usage is widespread
2. To mitigate the acceleration of evaporation during temperature increases and high swimming activity.

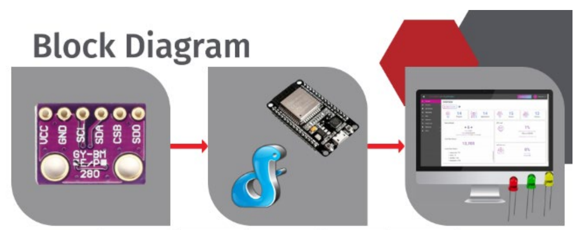
As previously mentioned, maintaining an appropriate pool environment enhances visitor comfort and reduces security risks, as the correct humidity level around the pool prevents deterioration of the building's walls and structure [5].

2.0 METHODOLOGY

Several components, including the BME280, ESP32, Light Emitting Diode (LED), and Favoriot platform, were employed in this project. It is divided into two sections: hardware and software coding.

Figure 3 illustrates the physical components of this system, including the ESP280 sensor, ESP32 microcontroller, Light Emitting Diode (LED), and project board. The microcontroller is programmed using the MicroPython programming language, developed with the uPyCraft IDE. The cloud platform is powered by a platform known as Favoriot.

"favoriot." This is due to the ease of access, application, and user interface function. Since the BME280 sensor can Simultaneously sensing three factors or variables temperature, humidity, and pressure has led to the decision to implement them in this project. With the inclusion of an inbuilt WiFi module in ESP32, the need for a separate WiFi shield is eliminated, resulting in enhanced performance compared to previous generations. The clock speeds of ESP32's two cores, ranging from 160MHz to 240MHz, are faster than those of the previous version. Additionally, this module features pins that facilitate SPI, I2C, UART, ADC, DAC, and PWM protocols, among others.



Parameter	W-Minimun	W-Maximum	R-Minimum	R-Minimum
Temperature	25°C	28°C	27°C	30°C
Humidity			50%	60%

Figure 3: Block Diagram of the System

The microcontroller downloads programs such as the BME280 library and the WiFi connection library, which the ESP32 initializes once the system is operational. Once initialization is completed, the sensor will start retrieving data, and the ESP32 will subsequently process it.

The collected data will then be transmitted to the cloud platform for storage and graphical representation. The microcontroller will process the sensor's data using a range of predefined system parameters. If the temperature exceeds 30 degrees Celsius, the red LED will illuminate; if the temperature falls below 28 degrees, the green LED will light up. If the temperature lies between 28 and 30 degrees Celsius, both LEDs will be illuminated.

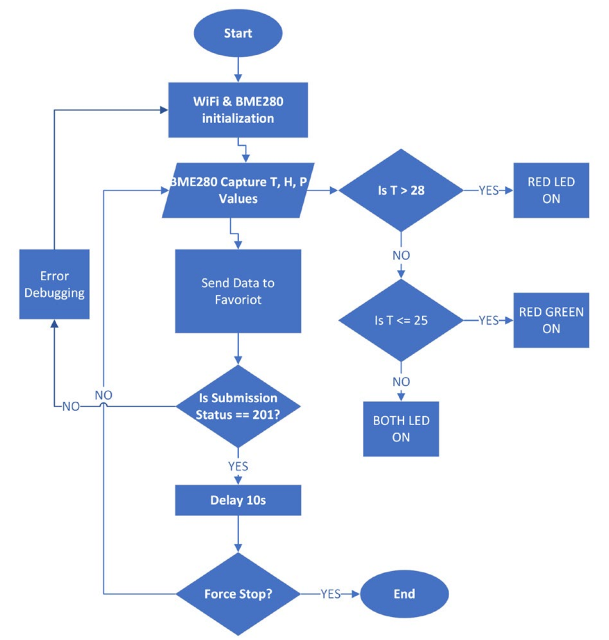


Figure 4: The Flowchart of the System

Figure 5 displays a list of every tool that had been put together. For power input, the BME280 is connected to pins 3.3V and GND. The sensor is then connected to pins 22 for SCL and pins 21 for SDA. Data from sensors is transmitted to the ESP32 using both pins. The GND pin for the cathode and pin 12 for the anode are both connected to the red LED. The green LED is then attached to pin 14 for the anode and pin GND for the cathode.

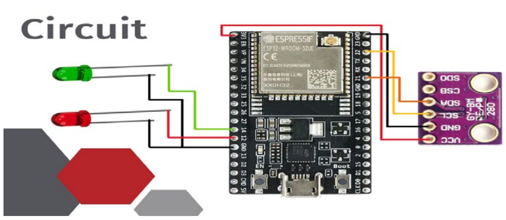


Figure 5: The Circuit

3.0 RESULTS & DISCUSSION

The goal of this project which is shown in figure 6 is to make it easier to monitor temperature and humidity data in swimming pools and other areas where swimming pools are intended to be developed. The criteria that establish the minimal environmental conditions that are suitable to be utilized as a swimming pool in order to ensure that visitors feel comfortable will be the acquired temperature and humidity data.

For this project, two locations were selected to evaluate the real-time monitoring of temperature and humidity. The first location is a swimming pool located inside Gedung Tokong Nanas at Telkom University. Meanwhile, the second location is Situ Tekno Lake which is also located inside Telkom University. These locations were chosen because each of them represents an indoor and outdoor condition, respectively.

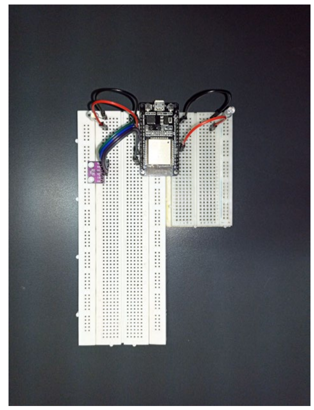


Figure 6: Project Prototype

A graph of the sensor readings from a period of around 10 minutes on January 25, 2023, is presented in Figure 7. 20.91 degrees Celsius has been recorded as the least temperature and 22.50 degrees Celsius as the highest. The temperature measurements initially increased sharply by 2 degrees before becoming fluctuating with little variation. This is due to the fact that the indoor environment can keep a more stable temperature in the first place.

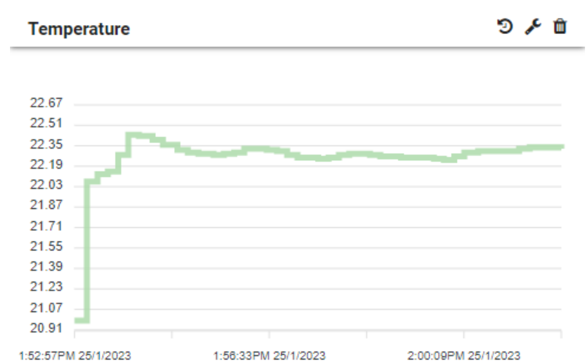


Figure 7: 1st Location Temperature

Figure 8 represents a graph of the sensor readings gathered over the duration of around 10 minutes on January 25, 2023, at different locations. The temperatures that have been recorded thus far vary between 21 degrees to 23.40 degrees. The temperature measurements initially increased rapidly by more than 2 degrees before quickly decreasing and fluctuating between 21 and 22.20 degrees. This is due to how rapidly and how many external variables are affected by the outdoor environmental conditions at the second location.

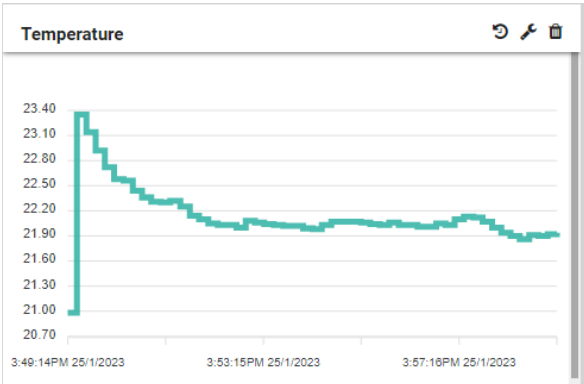


Figure 8: 2nd Location Temperature

Figure 9 shows a graph of the sensor values collected at the first location on January 25, 2023, for around 10 minutes. The sensor has detected a minimum humidity level of 70% and a maximum humidity level of 79.5%. The humidity initially rises at 8% degrees and then slowly fluctuates between 76% and 79%. This is due to the fact that humidity will remain in the area for a longer period of time, especially if the area contains water and has poor ventilation.

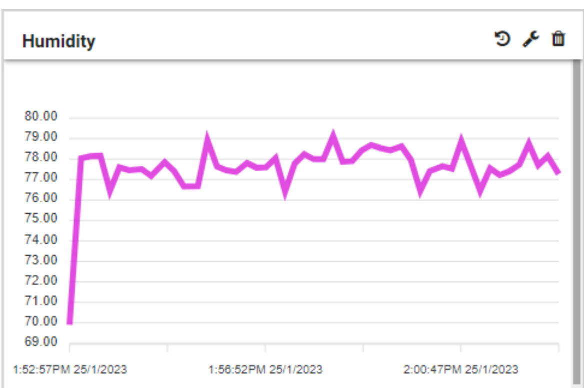
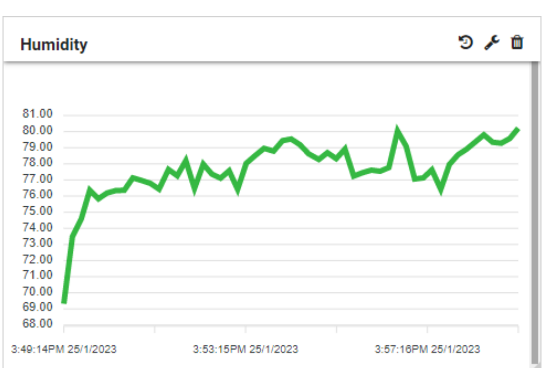


Figure 9: 1st Location Humidity

Figure 10 displays a graph of the sensor data obtained at the second location for approximately 10 minutes on the same day. The sensor has detected a minimum humidity level of 69.5% and a maximum humidity level of 80.5%. The humidity first increases gradually, up to a maximum of 7% degrees, then starts to vary significantly between 75% and 80.5%. This is due to the fact that, depending on the air and surroundings, outdoor humidity can change quickly.



For each location to be used as a swimming pool, there are benefits and disadvantages depending on the temperature and humidity measurements that have been taken. Outdoors, the atmosphere may be dryer so that it doesn't feel overly humid. However, depending on the weather and other factors in the environment, temperature, and humidity can rapidly change. Temperatures can be better controlled indoors, but humidity levels can be more challenging to manage.

4.0 CONCLUSION & RECOMMENDATION

Based on the measurements, indoor swimming pools are recommended due to their ability to shield against the volatile outdoor conditions and maintain a more consistent temperature. However, several factors must be considered during the design and planning phases. Given that indoor environments are typically enclosed, meticulous planning is essential for the construction and architecture of the building. This precaution is necessary to prevent room moisture from infiltrating the walls, as this can result in the growth of fungi and compromise the integrity of the building's structure.

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