*Journal of Engineering Technology Vol. 11(1): 41-45,*
*2023 ISSN 2231-8798© 2013 UniKL BMI*

# Analysis of the Influence of Human Activity and Weather on Open Space Areas

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**Abstract:** An open area within a building is referred to as a "open space area" and is typically found in office or academic buildings. In the analysis of changes in variables like temperature, humidity, and pressure driven by weather and human activity in open space regions, health and occupant comfort are given specific consideration. The purpose of the study is to comprehend how climate change and human activity will impact open space area temperature. Besides that, this project is to determine whether human activities and weather significantly affect the room temperature, humidity, and pressure using BME280 sensor in every 14 seconds. A prototype for real-time data collection using IoT technology for monitoring the quality of air will be created. It required to operate both software and hardware. For software, it requires MicroPython program, uPyCraft IDE, and Favoriot Cloud Platform, while for hardware, it requires devices such as BME280 sensors, ESP32, and Project Boards. The result shows that when the temperature is higher, the humidity and the pressure are lower, depending on the changes in the weather and human activities. This technology is anticipated to monitor the weather on open space areas for human activity.

**Keywords:** *Monitoring System, Internet of Things, Microcontroller, BME280 Sensor, Favoriot*

## 1.0 INTRODUCTION

In the realm of architectural and environmental studies, the dynamics of open space areas within buildings have garnered increasing attention due to their pivotal role in shaping human comfort and well-being. Open space areas, characterized by their unobstructed interiors and absence of partitions, often find their place in office complexes and academic institutions. These areas, although bounded by walls, create an environment that interfaces with both interior design and external climatic conditions. The complex interplay between architectural design, human activities, and external weather patterns has prompted a growing interest in investigating the intricate relationship between these factors and the microclimatic conditions experienced within these open spaces.

Health and occupant comfort receive special attention in the analysis concerning the fluctuations of factors such as temperature, humidity, and pressure influenced by weather and human activities in open space areas. Extreme variations in microenvironmental conditions can significantly impact the health and well-being of individuals within [1]. The excessive fluctuation of temperature, excessive humidity, or overly dry conditions can affect productivity, concentration, and the overall experience of engaging in activities within the open space. Thus, maintaining an environment that supports occupant health and comfort becomes a paramount concern. Proper temperature regulation, balanced humidity maintenance, and appropriate air pressure monitoring are essential steps to establish an environment conducive to well-being, ultimately promoting optimal conditions for activities and creativity.

Several studies have been conducted on how weather affects room temperature. A sensor monitoring system for interior climate factors was developed by Ioana Udrea et al. The created application reads the values recorded by the sensors, analyzes the information, and then sends the data to the IoT ThingSpeak platform. The vast area that is typical of open-plan offices reduces the impact of radiant barriers, allowing the operating temperature to be close to that of the surrounding air. The air speed inside this type of building, which is often low because of the air conditioning system, could be approximated by the design. This developed application was implemented to obtain data read from sensors using the PMV computer. The ThingSpeak IoT platform receives the data taken from the sensors as well as the fully calculated PMV [2].

Glen P. Kenny et al. combine heat and high humidity when relative humidity is included with the actual air temperature in order to establish evidence-based advice on maximum indoor temperatures during hot weather in temperate continental areas. The goal of this study is to assess the connection between outside temperature and human health as well as how high inside temperatures during heat waves may also have a negative impact on human health. The outcome demonstrates that the actual air temperature as well as other meteorological factors that can affect how the air feels are both important (i.e., humidity and wind). This measure was included in several research to evaluate the impact of heat on mortality [3].

The research by Noval Setyanugraha et. al. proposed a system that can predict weather changes. Three supporting criteria, including air pressure, humidity, and temperature, were employed in this system to facilitate the employment of the Mamdani and Sugeno fuzzy logic approaches. The accuracy of the Mamdani and Sugeno methods in this study's data levers, which were performed in June 2022, was 73.34% and 70%, respectively [4].

A microsystem that uses inductive power, data transmission over a backscatter-modulated carrier, and a transducer interface while keeping an eye on its surroundings using built-in capacitive transducers. This is formed on a single chip, and silicon-on-glass technology is used to realize temperature, pressure, and low humidity transducers [5].

Through the use of Internet of Things (IoT) technology, Alifia Sekar Ratri et al.'s research created a technology-based weather monitoring system that can be accessed without being physically present in the targeted location. This design's goal is to make it simpler to obtain meteorological data online and to analyse variations in rainfall, temperature, humidity, and air pressure in specific locations. The following weather variables can be measured: temperature, precipitation, humidity, light intensity, wind direction, and wind speed. [6].

Dr. A. Naveena designed and developed a Real-Time Weather Monitoring System (RTWMS). This necessitates the need to observe and analyze climatic changes and thus enable accurate prediction of weather patterns. A low-cost and user-friendly Real-Time Weather Monitoring System (RTWMS) that monitors and analyzes the environmental parameters like temperature and humidity, atmospheric pressure, rain, atmospheric gasses, and wind speed using DHT11, BME280, Raindrop sensor, MQ02, and win speed sensors respectively. MicroPython is the software interface for the sensors connected to the ESP32 board and the data thus acquired is posted to the cloud using ThingSpeak. The system, realized successfully, is a solution for remote weather monitoring that uses multiple sensors and the Internet of Things (IoT) and facilitates remote access to data from equipment deployed in geographical areas that are out of bounds for a civilian [7].

The A. F. Pauzi et al.-developed meteorological Reporting System is primarily utilised for real-time monitoring of the continuously changing climatic and meteorological conditions over restricted regions such as homes, businesses, farms, and other similar places. ThingSpeak is the platform for the Internet of Things (IoT). The weather parameters should be visible from anywhere in the world, and the information is also presented on an OLED screen using two-way microcontroller communication through Wi-Fi hotspots. The satellite weather report method does not provide a precise illustration of the state of a specific location. The issue arises, though, when a precise weather forecast for that particular moment is required. With the weather reporting system, an ESP32 microcontroller will be in charge of the all-weather parameter sensor. This sensor will be visible from anywhere in the world and will send all sensor data to a database maintained by ThingSpeak. It will also control an OLED display using a Wemos D1 mini microcontroller. Then, this data will be compared to statistics and weather forecast data compiled by the forecast station. The IFTT application will also save all captured data in Google Sheet format, making it simpler to analyse the data. This system will keep updated on weather changes happening around the area and then give users an easy way to obtain information from anywhere. [8].

The research aims to

1. To analyze the temperature, humidity, and pressure
2. To find out the effect of human activity on the room temperature
3. To understand how climate change will affect open space area temperature

## 2.0 METHODOLOGY

In this system, it is required to operate both software and hardware. For software, it requires MicroPython program, uPyCraft IDE, and Favoriot Cloud Platform, while for hardware, it requires devices such as BME280 sensors, ESP32, and Project Boards. Fig. 1 shows a block diagram of the concept used. Starting with using the BME280 sensor as the input. The BME 280 is a sensor module that can measure humidity, temperature, barometric pressure, and altitude data. With this module, temperature, humidity, and pressure can be obtained. In the process flow, this system uses ESP32 and the micropython program using the uPyCraft IDE. The ESP32 microcontroller has the advantage of being a low-cost, low-power system with a WiFi module that is integrated with the microcontroller chip. The Bluetooth with dual mode and power-saving features makes it more flexible. The uPyCraft is used as it has a special feature to program ESP8266/ESP32. Finally, the Favoriot Cloud Platform output flow is utilized to present the outcomes of the data collected from the BME280 sensor.

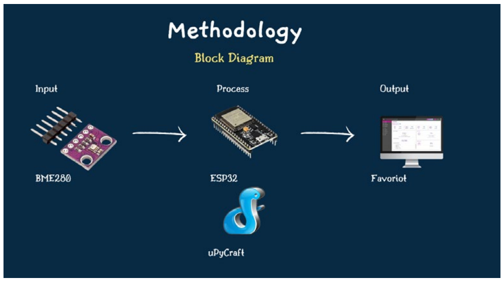

Fig 1. The block diagram of the Room Temperature Monitoring System

According to the system operational flowchart in Fig. 2, the system begins by initiating the BME280 sensor and WiFi. This initiation process requires several processes, including flashing the MicroPython firmware to the ESP32 board, running the BME280.py program, running the urequests.py program, running the boot.py program, and finally running the main.py program. The BME280 sensor collects the values of the T, H, and P parameters, which is T stands for temperature, H for humidity, and P for pressure if the starting procedure has been successful.

The data is successfully delivered to Favoriot if the submission status shows the number 201. If it does not show the number 201, check and debug the coding, then repeat the initiation step. The next phase is a delay, which sets the duration for the sensor to retrieve data. As indicated in the flowchart in Fig. 2, there is a 14-second delay, which means that the BME280 sensor will retrieve data from Temperature, Humidity, and Pressure every 14 seconds. Because of the while true command used in the programming, the program cannot be stopped other than by a Force Stop. This Force Stop can be caused by a number of things, including the forcible removal of a USB device, WIFI issues, and laptop crashes. If the thing that caused the Force Stop does not happen, the program will continue to run.

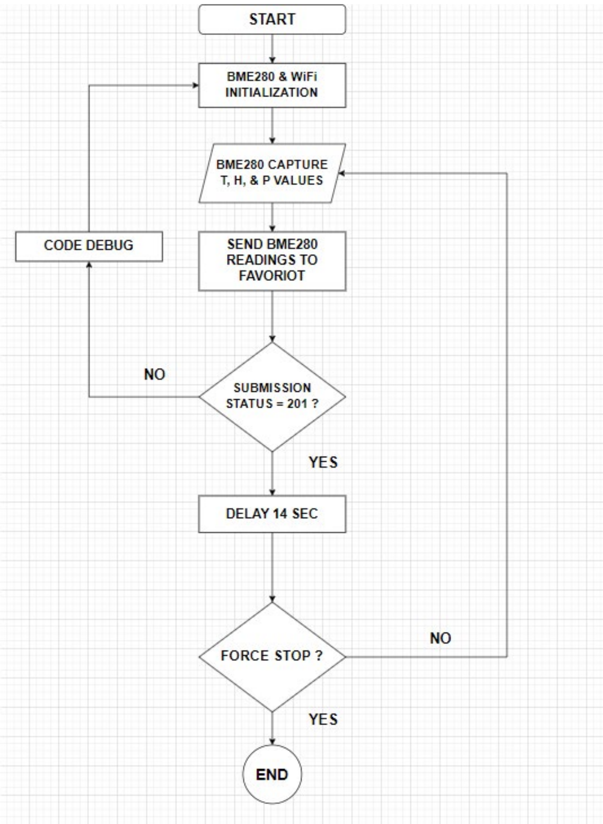

Fig.2 The flowchart of the IoT Room Temperature Monitoring System

Fig. 3 displays the circuit diagram. The circuit needed to connect the ESP32 Board and the BME280 sensor is displayed in the figure. The ESP32 pins that are used are 3V3, GND, GPIO 21, and GPIO 22. The VCC pin, GND pin, SDA pin, and SCL pin are all used by the BME280 sensor. Pin 3V3 is coupled with pin VCC in the circuit, followed by pin GND to pin GND, pin GPIO 21 to pin SDA, and pin GPIO 22 to pin SCL.

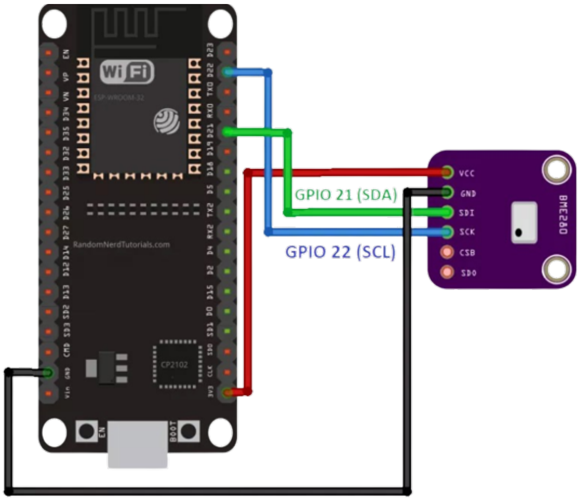

Fig. 3. Circuit diagram of the proposed system

## 3.0 RESULTS & DISCUSSION

This project was developed to analyze the impact of human activities on the environment in open space areas. The prototype was tested in two different locations which are open spaces areas, which are located on the 1st Floor G13, and the 4th Floor KoLab Canteen.

Fig. 4 (a) and 4 (b) show a photo from the test site that was carried out in the G13 Area and KoLab Canteen. There is less human activity in G13 due to the semester break. This place does not have air conditioning, therefore the temperature in this area is very depending on the weather changes. However, the situation at KoLab Canteen is crowded due to activities such as presentations and meetings. The condition of the room at the KoLam Canteen depends on 3 conditions, the first is air conditioning, the second is when human activity is busy, and the third is weather changes.

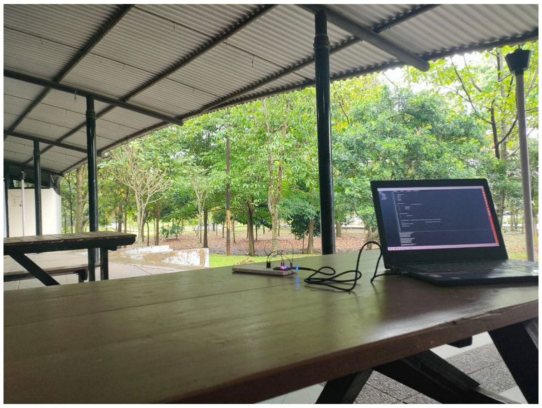

Fig. 4 (a). Location of 1st Floor G13

Fig. 4 (b). Location of 4th Floor KoLab Canteen

Fig. 5 (a). Temperature vs Time for 1st Floor G13

Fig. 5 (a) shows the graph of Temperature vs Time. The experiment was conducted from 13.30 until 14.00 for 30 minutes on 1st Floor G13. It shows the inconsistency of temperature between 22.64°C - 23.12°C due to rain and lack of human activity in that area.

Fig. 5 (b). Humidity vs Time for 1st Floor G13

The graph of Humidity vs Time is shown in Fig. 5 (b). The experiment was conducted from 13.30 until 14.00 on 1st Floor G13. For 30 minutes of the experiment, it shows that humidity is between 81.3% - 84.33% which is inversely proportional to the temperature.

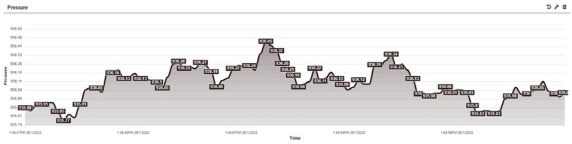

Fig. 5 (c). Pressure vs Time for 1st Floor G13

Fig. 5 (c) displays the graph of Pressure vs Time in the range of 30 minutes. The experiment takes place on 1st Floor G13 from 13.30 until 14.00. As shown in the graph, the value of the pressure is between 935.77hPa - 936.42hPa, the same as humidity, the results are inverse to the temperature.

Fig. 6 (a). Temperature vs Time for 4th Floor KoLab Canteen

Fig. 6 (a) shows the graph of Temperature vs Time at the 4th Floor KoLab Canteen. The experiment was conducted for 30 minutes from 14.00 until 14.30. It shows that the temperature is between 22.79°C - 24.82°C. Starting from 14.17 to 14.30 the temperature is constant due to the rain has been stopped and the area being crowded with human activities.

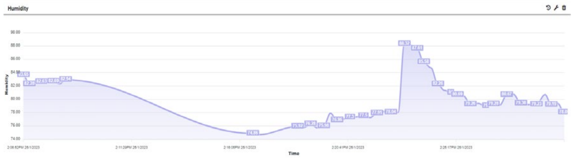

Fig. 6 (b). Humidity vs Time for 4th Floor KoLab Canteen

Fig. 6 (c). Pressure vs Time for 4th Floor KoLab Canteen

Fig. 6 (b) shows the graph of Humidity vs Time while the Pressure vs Time graph shows in Fig. 6 (c) at the same place. The experiment was conducted from 14.00 until 14.30 for 30 minutes. As shown in the graph, the humidity is between 74.86% - 84.71% while the pressure is between 929.89hPa - 935.71hPa due to the changes in the temperature.

Human activity can be used as an explanation for why the humidity levels in the 4th Floor KoLab Canteen were lower than those in the 1st Floor G13. Humidity ranged from 81.3% to 84.33% on the first floor G13, where no human activity took place between 13.30 and 14.00 during the trial. Fewer moisture sources resulted in increased humidity when there were fewer people around. The humidity ranged from 74.86% to 84.71% in the second location, where human activity was prevalent from 14.00 to 14.30. Although the activities of the occupants added moisture to the area, the enhanced ventilation brought about by the activities may have aided in moisture evaporation, resulting in a minor drop in humidity. These variations highlight the significant influence of human behavior on indoor humidity dynamics, which affects the observed humidity oscillations at various times and places.

On the other hand, despite the difference in elevation, there may be a correlation between pressure fluctuations on the bottom floor (935.77hPa to 936.42hPa) and the fourth floor (929.89hPa to 935.71hPa). The decreased pressure on the fourth floor is a result of the pressure gradient, a phenomenon where pressure drops as elevation rises. However, the apparent pressure resemblance may be the result of temperature variations' overall influence on pressure patterns, demonstrating how various weather conditions in various areas may result in a similar pressure response.

## 4.0 CONCLUSION & RECOMMENDATION

In this work, a prototype of a monitoring system for Analyze of the Influence of Human Activity and Weather on Open Space Areas is proposed. The obtained results run by the proto-type measurements demonstrated at two different locations, which are 1st Floor G13 and 4th Floor KoLab Canteen. The result shows that when the temperature is higher, the humidity and the pressure are lower, depending on the changes in the weather and human activities.

In the future, the research can be improved by adding more sensors such as anemometer sensors to detect the presents of wind and measure wind speed in the vicinity which is also widely used in weather measurement stations. This is achieved by using the internet of things (IoT) concept for device-to-device communication and managing the real-time data in a cloud database.

## ACKNOWLEDGMENT

This project was conducted by student and staffs of Telkom University Bandung and Universiti Kuala Lumpur British Malaysian Institute (UniKL BMI) and its publication is financially supported by the university. Therefore, the authors would like to thank Telkom University for the provision of laboratory facilities and financial support.

## REFERENCES

[1] P. Wolkoff, K. Azuma, and P. Carrer, “Health, work performance, and risk of infection in office-like environments: The role of indoor temperature, air humidity, and ventilation,” *International Journal of Hygiene and Environmental Health*, vol. 233. Elsevier GmbH, Apr. 01, 2021. doi: 10.1016/j.ijheh.2021.113709.

[2] I. Udrea *et al.*, “IoT solution for monitoring indoor climate parameters in open space offices,” in *E3S Web of Conferences*, EDP Sciences, Jul. 2020. doi: 10.1051/e3sconf/202018002012.

[3] G. P. Kenny, A. D. Flouris, A. Yagouti, and S. R. Notley, “Towards establishing evidence-based guidelines on maximum indoor temperatures during hot weather in temperate continental climates,” *Temperature*, vol. 6, no. 1. Routledge, pp. 11–36, Jan. 02, 2019. doi: 10.1080/23328940.2018.1456257.

[4] N. Setyanugraha, S. al Aziz, and I. Widya Harmoko, “Study of a Weather Prediction System Based on Fuzzy Logic Using Mamdani and Sugeno Methods.” [Online]. Available: http://journal.unnes.ac.id/nju/index.php/pc

[5] A. D. DeHennis and K. D. Wise, “A wireless microsystem for the remote sensing of pressure, temperature, and relative humidity,” *Journal of Microelectromechanical Systems*, vol. 14, no. 1, pp. 12–22, Feb. 2005, doi: 10.1109/JMEMS.2004.839650.

[6] “2 Alifia Sekar Ratri-Design Of Weather Condition Monitoring System Based On Internet Of Things.” [Online]. Available: https://ejournal.unsrat.ac.id/index.php/informatika

[7] A. Naveena, “© ICAS 2022 ANALYSIS OF REAL TIME WEATHER MONITORING SYSTEM USING THINGSPEAK,” 2022. [Online]. Available: https://www.e-afr.org/

[8] A. F. Pauzi and M. Z. Hasan, “Development of IoT Based Weather Reporting System,” in *IOP Conference Series: Materials Science.*