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Emergency Stairs Monitoring System at Telkom University

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Abstract: Emergency exit stairs are one of the most effective solutions for safe evacuation in the fire emergency. However, not all ladders guarantee a quick and safe exit for building occupants in an emergency. In this situation, there will be a lot of people using the emergency stairs, and it will affect the temperature, pressure, and people suffocated to breathe. So in that emergency situation and on the stairs, a lot of people don't feel the excessive heat and have difficulty breathing. The emergency staircase's temperature, humidity, and pressure are all monitored by this system using BME280 sensors. This technology makes advantage of a WiFi network to resist fire. In the event of the fire, occupants can use a smart mobile application that provides real-time data on the number of people, temperature, humidity, and pressure in the emergency staircase. The airflow in these spaces, a key computational component of the architecture, supports the design choice by giving the model anticipated operational and computational delays. preliminary analyses based on information from an actual situation and the advice to use a flame detector to determine whether the fire is reaching the emergency stairwell.

Keywords: *Emergency, Emergency Staircase, Sensor, IoT, Favoriot*

1.0 INTRODUCTION

Emergency exit staircase are among the best solutions for a safe evacuation during the fire emergency. However, not every staircase ensures that building inhabitants may leave quickly and safely in an emergency. In an emergency situation, there will be a lot of people utilising the emergency stairs, which will affect the temperature, pressure, and people's ability to breathe. So that individuals won't become overheated and struggle to breathe on the stairs or in an emergency.

A report on stair-related injuries handled in emergency rooms in the United States can be found in [1]. We looked at data from the National Electronic Injury Surveillance System for people who were treated in emergency rooms in the US for stair-related injuries. It is clear that stairway accidents affect persons of all ages often, and that both their frequency and frequency are increasing.

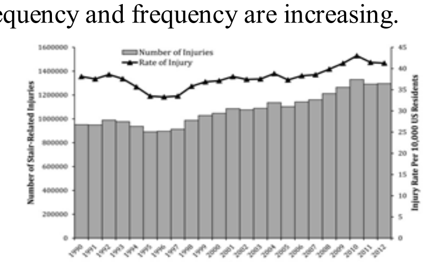

Fig.1 Number and rate of injuries [1]

Real-time performance and evacuation time are crucial for safety-critical systems like evacuation. A real-time emergency response through high-performance IoT solutions to be verified by computer simulation was proposed by Claudio Arbib et al. The results indicate that the only workable method is to split the space into huge cubes using a centralized architectural design [2].

Zualkernan et al. presented an emergency evacuation system based on the Internet of Things (IoT). The technology employs Bluetooth Low Energy (BLE) beacons through the utilisation of users' mobile phones to facilitate indoor localization. The system tracks the location of the residents of the building and the location of the fire in order to be resilient in the event of a fire. Then, it uses a variety of networks, like digimesh and wifi, to guide them intelligently to a secure exit. Residents can utilise a high-tech mobile application to see a live map of the current danger levels inside the building in the case of a fire. Smart exit signs have been erected all over the building to guide occupants to safety. These signs dynamically change their state based on the location of the fire [3].

This paper makes the following objectives:

1. To study the effect of BME280 on temperature and pressure at the exit staircase.
2. To analyze the effect of humidity and pressure at the emergency exit staircase using BME280.

3. To evaluate the pressure at different floors.

2.0 METHODOLOGY

The suggested development of the idea of temperature, humidity, and pressure in emergency stairs using the BME280 sensor is illustrated in the block diagram in Figure 2. The BME280 sensor has an i2c interface and can access data for measuring humidity, temperature, and barometric pressure. This sensor is simple to use due to its pre-calibrated feature. It is required to use ESP32, BME280, and ESP32 that run using Upycraft, and the output will be displayed in a Favoriot dashboard.

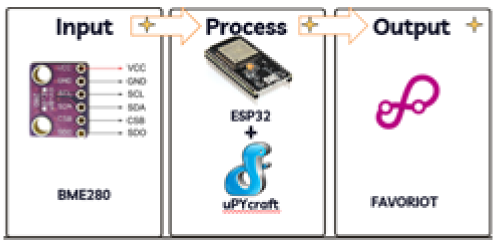

Fig 2. The block diagram of Emergency Staircase Monitoring System

According to Figure 3's flowchart of the system's operational steps, the BME280 sensor and Wi-Fi are initially initialised by the system. Then, the sensor measures and calculates temperature, humidity and pressure. To ensure a successful connection between the user's device and the hardware and their preferred server, the system will transmit a signal to that server over the internet. The BME280 sensor sends a ping signal to confirm connection establishment and waits for the server to confirm the connection. If it's connected, check to see if the submission status is 201; If it is, the system will read the delay provided in the code; if it's not, the system will ask you to verify the code before starting the BME280 sensor and wifi. The programme or data retrieval will cease if the system detects a forced stop after a delay; otherwise, it will continue to run until it is stopped..

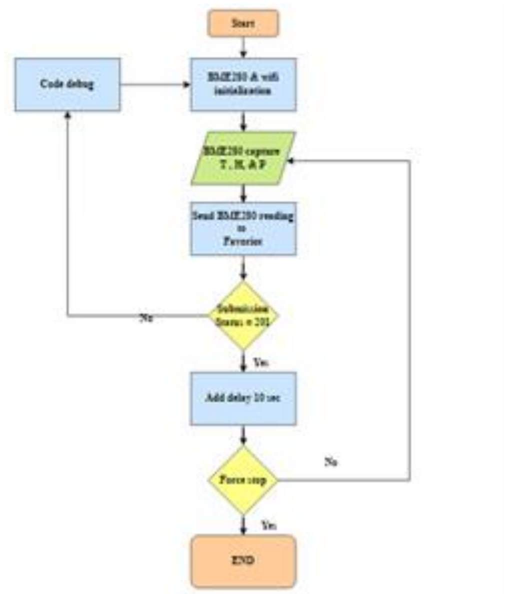

Fig.3 The flowchart of IoT Emergency stairs Monitoring System

The circuit diagram illustrated in Figure 3 is intended to connect the BME280 as an input to the ESP32. This circuit diagram is straightforward as it consists of only two modules, ESP32 and BME280. The BME280 sensor module can retrieve information regarding temperature, humidity, and pressure. Additionally, ESP32 is used for communication between the server and sensor.

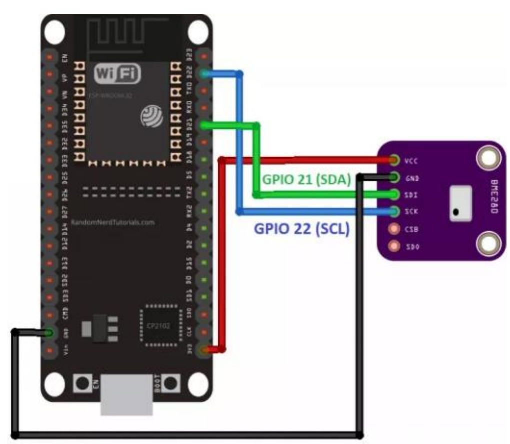

Fig. 4. Circuit diagram of the Monitoring System Emergency Staircase

3.0 RESULTS & DISCUSSION

Favoriot was used in this project as a dashboard to track changes in humidity, pressure, and temperature on various floors.

Fig. 4a shows the actual proof of concept circuit developed for this project. To start the system evaluation, the respective micropython file codes were downloaded and run on the ESP32 microcontroller via uPyCraft IDE. The

BME280 sensor is strategically positioned in two distinct locations, specifically the emergency staircases on the first and third floors. The figures 4a and 4b depict the respective locations of the emergency staircases.

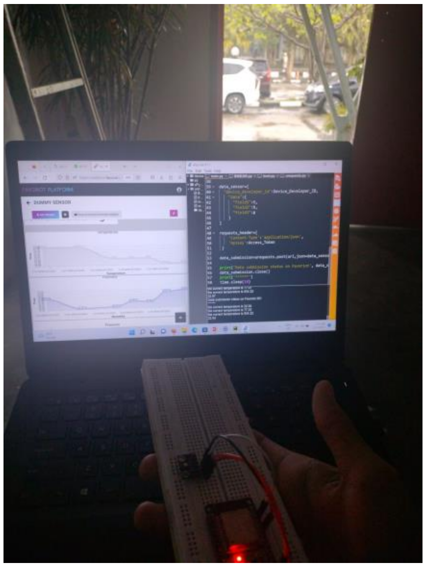

Fig. 5a. First floor emergency staircase

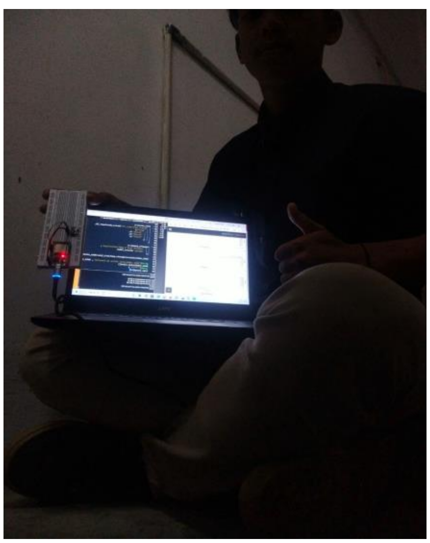

Fig. 5b. Third floor emergency staircase

Fig. 6a. Temperature vs Time first floor emergency staircase

An image of a temperature vs. time graph can be seen in Figure 6a. The experiment took place on the first level from 01.24pm to 01.48pm and lasted 30 minutes. As can be seen, the graph ranges between 22.24 °C and 23.4 °C. Starting from 1.33 pm the temperature is decreasing due to airflow from the door open that reduce the temperature.

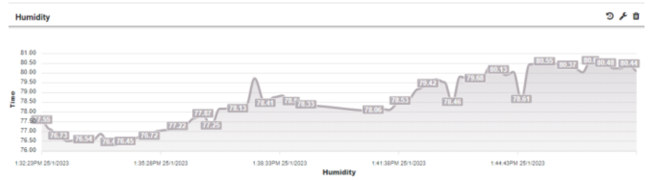

Fig. 6b. Humidity vs Time in first floor

Figure 6b shows a graph of humidity vs time. The 30-minute trial ran on the first level emergency staircase from 01.24pm to 01.48pm. The graph shows a range of 77.45% to 80.55%. since the emergency staircase area is colder, changing and humidity to rise.

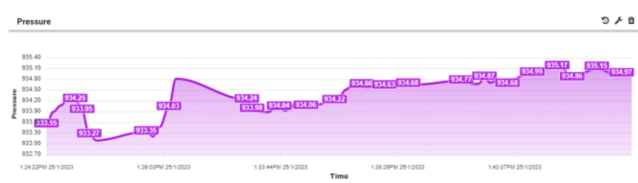

Fig.6c. Pressure vs Time in first floor

Figu6e 6c shows a pressure vs. time graph. The 30-minute experiment was conducted at the first level emergency staircase from 01.24 to 01.48. As can be observed, the graph's pressure spans from 933.27 hPa to 934.97 hPa. Changing and prone to rise as a result of the room's dropping temperature and increasing humidity in the emergency staircase.

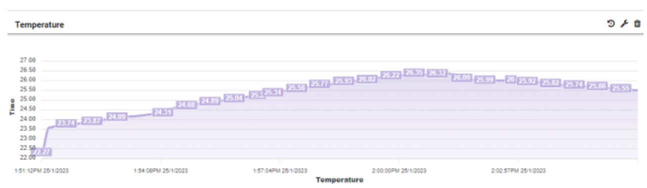

Fig. 7a. Temperature vs Time in third floor

An image of a temperature vs. time graph can be seen in Figure 7a. The experiment took place on the third level from 01.51 pm to 02.06 pm and lasted 15 minutes. As can be seen, the graph ranges between 22.27 °C and 25.55 °C. The longer it stays closed off and without airflow, the hotter it becomes.

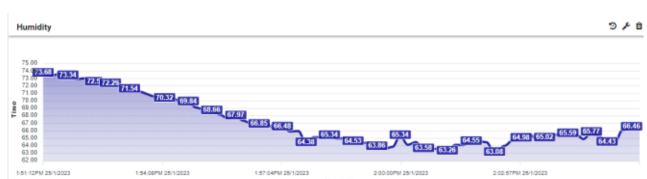

Fig. 7b. Humidity vs Time in third floor

Figure 7b shows a graph of humidity vs time. The 15-minute trial ran on the third level emergency staircase from 01.51 pm to 02.06 pm. The graph shows a range of 63.08% to 73.68%. not constant and often drops due to the emergency staircase's temperature rise

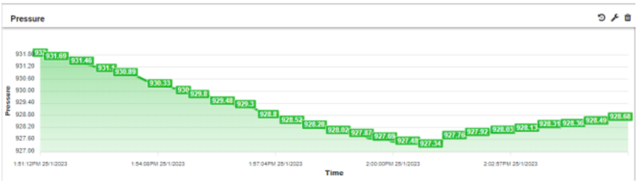

Fig. 7c. Pressure vs Time in third floor

Figure 7c shows a pressure vs. time graph. The 15-minute experiment was conducted at third level emergency staircase from 01.51 pm to 02.06. As can be observed, the graph's pressure spans from 927.34 hPa to 932 hPa. changed and tended to decrease when the room's temperature increased and the humidity level on the emergency stairs decreased.

4.0 CONCLUSION & RECOMMENDATION

This study presents a potential prototype for a monitoring system designed specifically for emergency staircases. The findings indicate that there are variations in temperature, humidity, and pressure between the emergency staircases located on the first and third levels. The contrasting environmental conditions between the two locations can be attributed to the presence of open space and airflow in the first site, whereas the second location is characterised by a closed and stuffy atmosphere. Consequently, individuals may experience a heightened susceptibility to asphyxiation. Therefore, it is strongly suggested to use the necessary respirators.

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