# Chapter 6. Testing and Evaluation

**Chapter Specific Material:**

This chapter should include a description of the process or processes you used to test and evaluate your system. You can use things such as user experience reports, attempts by yourself or others to break your own code, graphs/charts of outputs or performance, etc. Include discussions of why things work, and why and when they don’t work. You can also include any refinements made to your implementation as a result of your testing.

In this chapter, we will describe the processes used to test and evaluate the IoT system designed to monitor environmental parameters using various sensors and ThingSpeak for data visualization. The evaluation includes testing the functionality of each sensor, the integration with ThingSpeak, and the overall system performance. We will also discuss the refinements made to the implementation based on the testing results.

**1. Testing the Gas Sensor**

Process:

- Gas sensor was tested by adding a gas source close to it and watching the changes in state.  
- For verification, the sensor state was printed to the terminal (0 for no gas, 1 for gas present)

**Results:**

- The gas sensor correctly identified the gas's presence and adjusted its condition.   
- The terminal printouts "Gas state: Gas present" or "Gas state: No gas" were used to confirm the output.   
- If the sensor detects any gas, a green light will blow.

**Issues and Refinements:**

* We cannot determine which specific gas is present because we don’t have ADC to detect specific gas.

**2. Testing the DHT11 Sensor with buzzer**

**Process:**

- The DHT11 sensor underwent testing by being subjected to various humidity and temperature conditions.   
-The terminal was printed with the temperature and humidity measurements for confirmation.   
-A buzzer will sound if the temperature rises above the set 25 degrees.

**Results:**

* The sensor provided accurate readings within the expected range.
* Terminal prints showed real-time data: "Temperature: X.X°C" and "Humidity: Y.Y%."

**Issues and Refinements:**

* Occasionally, the sensor would fail to read data, throwing runtime errors. Added error handling to manage these exceptions gracefully.

**3. Testing the CO2 Sensor**

**Process:**

* The CO2 sensor was tested by exposing it to different CO2 concentrations.
* The CO2 readings, air quality, and health implications were printed to the terminal for verification.

**Results:**

* The CO2 sensor accurately measured the CO2 levels and correctly categorized the air quality.
* Terminal prints showed: "CO2: XXXX ppm," "Air Quality: Excellent/Good/Unhealthy," and "Health Implications: X."

**Issues and Refinements:**

* It requires like approximately 1 min to preheat the sensor.
* At first, the serial port was having communication issues. improved serial communication retries and checks.

**4. Integration with ThingSpeak**

**Process:**

* Data from all sensors were sent to ThingSpeak every 30 seconds using write API key
* The ThingSpeak channel was configured to visualize the data in real-time.

**Results:**

* The integration was successful, and the ThingSpeak dashboard now shows real-time data.
* Graphs showing the temperature, humidity, CO2 levels, and gas status were all included in the data display.

**Issues and Refinements**:

* Occasionally, data failed to upload due to network issues. Added retries and error logging for ThingSpeak uploads.

**5. Overall System Performance**

**Process:**

* **We need to take**
* Over several days, the entire system was tested for continuous operation in order to assess performance and stability.
* A variety of users were asked to engage with the system and view the data visualizations in order to gather user experience.

**Results:**

* The system operated continuously without significant downtime.
* Users found the data visualization on ThingSpeak helpful and easy to interpret.

**Issues and Refinements:**

* Users reported that the ThingSpeak graphs were unclear because they lacked labels and legends.
* To improve clarity and user understanding, we added more descriptive labels and legends to the ThingSpeak graphs.