4.4 – Comfort Room system testing

To validate the functionality and efficiency of the Smart Light and Temperature System, testing was conducted in multiple stages:

**4.4.1 - Individual Component Testing:**

Each hardware component was tested individually to confirm correct operation:

* **PIR sensor**: Detected motion accurately and triggered test signals .
* **Light sensors (LDR**): Accurately detected ambient light levels and responded to changes**.**
* **Infrared Sensor :** Accurately detected obstacles
* **DHT sensor**: Provided consistent temperature and humidity readings.
* **Firebase realtime** : Successfully connected to Wi-Fi and communicated with Firebase Realtime Database.
* **Mobile App**: Able to retrieve and display data from Firebase and send control commands.

**2. Subsystem Integration:**

After ensuring that each component worked independently, components were tested in logical pairs and subsystems:

* **Infrared Sensor** have been tried in pairs to test the idea of entry counter
* The **PIR sensor** was connected to the ESP and tested to trigger the **relay** and control light status.
* The **DHT sensor** was linked to the ESP32 to read and send temperature data to Firebase.
* The **LDR sensor** was integrated with logic to determine light intensity and influence relay behavior.
* The **ESP32** was tested with Firebase to ensure real-time synchronization of data and commands.  
  This phase required several iterations of code updates, especially for handling delays, sensor thresholds, and ensuring reliable Wi-Fi connection.

**3. Full System Integration:**

Once subsystems were validated, all components were integrated into a complete system:

* Real-time data from **motion**, **temperature**, and **light sensors** was processed and sent to Firebase.
* The **mobile app** displayed sensor data and allowed users to manually control lights.
* The **relay** responded either automatically based on motion and light conditions or manually through the app.
* Logic was added to gradually dim lights after one hour of inactivity, with the ability to restore brightness if new motion was detected.

Final testing included simulations of different scenarios (e.g., no motion, dark room, high temperature) to ensure all features worked as intended. After multiple trials and minor code refinements, the system achieved stable and reliable operation.