RINGKASAN

Particulate Matter 2.5 (PM2.5) merupakan salah satu polutan udara yang paling berbahaya bagi kesehatan manusia karena partikelnya yang sangat halus dapat masuk ke saluran pernapasan hingga ke alveoli paru-paru. Paparan PM2.5 dalam jangka pendek maupun panjang dapat menyebabkan gangguan pernapasan, penyakit kardiovaskular, hingga meningkatkan risiko kematian dini. Berdasarkan Indeks Standar Pencemar Udara (ISPU), konsentrasi PM2.5 yang melebihi ambang batas dianggap berbahaya dan memerlukan tindakan pengendalian serta pemantauan secara intensif.

Penelitian ini bertujuan untuk memperluas cakupan pemantauan kualitas udara dengan menambahkan titik pengukuran PM2.5 di wilayah Muaro Jambi, tepatnya di Universitas Jambi. Langkah ini penting karena saat ini Provinsi Jambi hanya memiliki tiga stasiun pemantauan yang dikelola oleh BMKG. Sistem yang dirancang menggunakan sensor biaya rendah (*low-cost sensor*) yang terintegrasi dengan teknologi komunikasi LoRa menggunakan topologi *star*, serta antarmuka pengguna yang sederhana dan mudah dioperasikan.

Metode yang digunakan dalam penelitian ini adalah *Analysis, Design, Development, Implementation, Evaluation* (ADDIE). Hasil pengujian menunjukkan bahwa sistem mampu mengukur suhu, kelembapan, dan konsentrasi PM2.5 dengan tingkat akurasi yang tinggi. Rata-rata akurasi pengukuran suhu mencapai 98,04% pada *Node Master* dan 99,62% pada *Node Slave*. Untuk kelembapan, akurasi tercatat sebesar 98,07% pada *Node Master* dan 98,75% pada *Node Slave*. Sedangkan akurasi pengukuran PM2.5 mencapai 92,45% di *Node Master* dan 90,21% di node slave. Sistem LoRa optimal dilakukan hingga jarak 300 meter, baik pada kondisi *Line-of-Sight* (LOS) maupun *Non-Line-of-Sight* (NLOS), tanpa kehilangan paket data. Temuan ini menunjukkan bahwa sistem yang dikembangkan dapat menjadi alternatif solusi monitoring udara yang efektif untuk daerah yang belum memiliki jaringan pemantauan kualitas udara resmi.

Kata Kunci: Kualitas Udara, *Low-Cost Sensor*, LoRa.

SUMMARY

Particulate Matter 2.5 (PM2.5) is one of the most hazardous air pollutants to human health due to its extremely fine particles, which can penetrate the respiratory tract and reach the alveoli in the lungs. Both short-term and long-term exposure to PM2.5 can lead to respiratory disorders, cardiovascular diseases, and an increased risk of premature death. According to the Air Quality Index (Indeks Standar Pencemar Udara – ISPU)*, PM2.5 concentrations that exceed the established threshold are classified as dangerous and require intensive monitoring and control measures.*

This study aims to expand the scope of air quality monitoring by adding a PM2.5 measurement point in the Muaro Jambi region, specifically at Universitas Jambi. This initiative is crucial, considering that the Jambi Province currently has only three air quality monitoring stations managed by BMKG (Meteorological, Climatological, and Geophysical Agency). The system was designed using low-cost sensors integrated with LoRa communication technology, previously implemented in a star topology configuration, and supported by a simple, user-friendly interface.

The research method applied follows the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). The test results indicate that the system is capable of measuring temperature, humidity, and PM2.5 concentrations with a high level of accuracy. The average temperature measurement accuracy was 98.04% on the Master Node and 99.62% on the Slave Node. For humidity, the accuracy was recorded at 98.07% on the Master Node and 98.75% on the Slave Node. Meanwhile, the PM2.5 concentration measurements showed an accuracy of 92.45% on the Master Node and 90.21% on the Slave Node. The LoRa communication system functioned optimally at distances up to 300 meters under both Line-of-Sight (LOS) and Non-Line-of-Sight (NLOS) conditions, without any packet loss. These findings suggest that the developed system has the potential to serve as an alternative solution for air quality monitoring, particularly in areas lacking official monitoring infrastructure..

Keyword: *Air Quality, Low-Cost Sensor, LoRa.*