

ABSTRAK

Kebersihan kandang merupakan salah satu faktor penting dalam menjaga kesehatan dan produktivitas ternak bebek. Proses pembersihan kandang yang masih dilakukan secara manual memerlukan waktu, tenaga, dan penggunaan air yang relatif besar, serta berpotensi menyebabkan penumpukan kotoran yang menghasilkan gas metana. Penelitian ini bertujuan untuk mengimplementasikan sistem pembersih kandang bebek otomatis berbasis *Internet of Things* (IoT) yang mampu mendeteksi kadar gas metana, melakukan penyiraman otomatis, serta memantau kondisi kandang secara *real-time*. Metode penelitian yang digunakan adalah Prototype, meliputi tahapan analisis kebutuhan, perancangan sistem, pembangunan prototipe, pengujian, dan evaluasi. Sistem dikembangkan menggunakan tiga node ESP32 yang saling berkomunikasi melalui protokol MQTT. Sensor MQ-4 digunakan untuk mendeteksi kadar gas metana, sensor DHT22 untuk memantau suhu lingkungan, sensor YF-S201 untuk mengukur penggunaan air, serta relay dan solenoid valve sebagai aktuator penyiraman otomatis. Data hasil pembacaan sensor ditampilkan secara *real-time* melalui *dashboard* Tuya dan aplikasi IoT MQTT Panel. Hasil penelitian menunjukkan bahwa sensor MQ-4 mampu mendeteksi kadar gas metana pada rentang 323196 ppm dengan nilai ambang aktivasi penyiraman sebesar 150 ppm. Hasil kalibrasi sensor DHT22 terhadap termometer digital menunjukkan rata-rata error sebesar 0,45%. Sistem memiliki rata-rata waktu respons penyiraman 2,2 detik, rata-rata waktu pengiriman data 2,04 detik, serta tingkat keberhasilan pengiriman data mencapai 100%. Selain itu, sistem mampu meningkatkan efisiensi waktu pembersihan sebesar 85,05% dan menghemat penggunaan air sebesar 81,48% dibandingkan metode manual. Berdasarkan hasil tersebut, sistem yang dikembangkan mampu melakukan pemantauan dan pembersihan kandang secara otomatis, cepat, dan efisien sehingga berpotensi meningkatkan efektivitas pengelolaan kebersihan kandang bebek.

Kata Kunci: *Internet of Things* (IoT), kandang bebek, ESP32, MQ-4, DHT22, MQTT, pembersih kandang otomatis, efisiensi air, monitoring *real-time*.

ABSTRACT

Maintaining cage cleanliness is an important factor in ensuring the health and productivity of duck farming. Conventional cage cleaning is still performed manually, requiring considerable time, labor, and water consumption, while allowing the accumulation of manure that produces methane gas. This study aims to implement an Internet of Things (IoT)-based automatic duck cage cleaning system capable of detecting methane gas concentration, activating an automatic water spraying mechanism, and providing real-time monitoring of cage conditions. This research employed the Prototype development method, which consists of requirement analysis, system design, prototype development, testing, and evaluation. The system was developed using three ESP32 nodes communicating through the MQTT protocol. An MQ-4 sensor was utilized to detect methane gas concentration, a DHT22 sensor to monitor ambient temperature, a YF-S201 water flow sensor to measure water consumption, and a relay with a solenoid valve to control the automatic spraying process. Sensor data were transmitted and displayed in real time through the Tuya dashboard and the IoT MQTT Panel application. The experimental results indicate that the MQ-4 sensor successfully detected methane concentrations ranging from 32 to 196 ppm, with an automatic spraying threshold of 150 ppm. Calibration of the DHT22 sensor against a digital thermometer resulted in an average error of 0.45%. The system achieved an average spraying response time of 2.2 seconds, an average data transmission time of 2.04 seconds, and a 100% data transmission success rate. Furthermore, the developed system improved cleaning time efficiency by 85.05% and reduced water consumption by 81.48% compared with the conventional manual cleaning method. These results demonstrate that the proposed system is capable of performing automatic, reliable, and efficient duck cage monitoring and cleaning, thereby improving the effectiveness of duck farm sanitation management.

Keywords: *Internet of Things (IoT), duck cage, ESP32, MQ-4 sensor, DHT22 sensor, MQTT, automatic cage cleaning, water efficiency, real-time monitoring.*