ABSTRAK

Budidaya ayam broiler merupakan sektor strategis dalam penyediaan protein hewani yang menuntut penerapan sistem pemeliharaan modern untuk menjaga kestabilan lingkungan kandang. Kandang closed house konvensional masih menghadapi tantangan berupa fluktuasi suhu, kelembapan, pencahayaan, kebisingan, serta akumulasi gas berbahaya yang berdampak pada kesehatan dan performa ayam. Penelitian ini mengembangkan sistem otomatisasi manajemen lingkungan berbasis Internet of Things (*IoT*) dengan integrasi sensor semi-industri, *Human Machine Interface (HMI*), *Programmable Logic Controllers (PLC),* dan *web-based monitoring.* Metode penelitian mencakup perancangan perangkat keras dan lunak, integrasi sensor suhu, kelembapan, cahaya, kebisingan, kecepatan angin, O_2, CO_2, dan NH_3, serta pengujian eksperimental dengan membandingkan kondisi kandang sebelum dan sesudah penerapan *IoT*. Analisis data dilakukan menggunakan uji *paired sample t-test, Wilcoxon*, dan analisis deskriptif untuk menilai perubahan kondisi lingkungan, performa ayam, efisiensi energi, dan tingkat kepuasan pengguna. Hasil penelitian menunjukkan bahwa suhu sebelum dan sesudah *IoT* berdistribusi normal (p=0,929) dengan perbedaan rata-rata tidak signifikan (p=0,080), tetapi pola suhu lebih stabil dan mendekati standar SOP (p=0,016). Kelembapan meningkat signifikan setelah penerapan *IoT* (p=0,000). Kebisingan berfluktuasi menurun namun meningkat secara rata-rata (p=0,003) akibat pengaruh kerja kipas otomatis. Kecepatan angin menurun signifikan (p=0,001) dan menjadi lebih terkendali melalui penerapan *Variable Frequency Drive (VFD*). Kadar O_2 menunjukkan tren indikasi kenaikan, sedangkan CO_2 menurun signifikan hingga di bawah ambang batas aman <3000 ppm (p<0,001). NH_3 mengalami indikasi terjadi penurunan. Parameter performa menunjukkan peningkatan nyata, dengan mortalitas menurun signifikan (p=0,005), deplesi berkurang di bawah 5% menjadi 3% (p<0,01), dan bobot badan meningkat signifikan 846,28 g menjadi 895,43 g (p<0,05). Nilai *Daily Gain (DG)* (p > 0.05) lebih tinggi sebelum *IoT* tetapi lebih setabil setelah *IoT* di terapkan. FCR tetap efisien (p>0,05), dan *Indeks Performa* (IP) meningkat dari 360,7 menjadi 414,2 meskipun belum signifikan (p>0,05). Pemantauan konsumsi energi listrik melalui sistem *smart metering* menunjukkan kecenderungan efisiensi, sejalan dengan pengaturan kipas berbasis *VFD* yang adaptif terhadap kondisi lingkungan. Penilaian *System Usability Scale (SUS)* terhadap sistem HMI dan website recording memperoleh skor 68–72 yang termasuk kategori *good usability.* Penerapan sistem *IoT* terbukti mampu meningkatkan kestabilan mikroklimat kandang, memperbaiki performa pertumbuhan ayam broiler, serta menekan potensi biaya energi operasional. Implementasi teknologi ini berkontribusi terhadap peningkatan efisiensi produksi dan daya saing peternakan broiler modern secara berkelanjutan.

Kata Kunci: *Internet of Things*, *Closed House,* Ayam Broiler, Efisiensi Pakan, Indeks Produksi

ABSTRACT

Broiler chicken farming is a strategic sector in the provision of animal protein that requires the implementation of modern maintenance systems to maintain the stability of the coop environment. Conventional closed houses still face challenges in the form of fluctuations in temperature, humidity, lighting, noise, and the accumulation of harmful gases that affect the health and performance of chickens. This research developed an Internet of Things (IoT)-based environmental management automation system with the integration of semi-industrial sensors, Human Machine Interface (HMI), Programmable Logic Controllers (PLC), and web-based monitoring. The research methods included hardware and software design, integration of temperature, humidity, light, noise, wind speed, O_2, CO_2, and NH_3 sensors, and experimental testing by comparing coop conditions before and after the implementation of IoT. Data analysis was performed using the paired sample t-test, Wilcoxon, and descriptive analysis to assess changes in environmental conditions, chicken performance, energy efficiency, and user satisfaction levels. The results showed that the temperatures before and after IoT implementation were normally distributed ($p=0.929$) with no significant difference in mean ($p=0.080$), but the temperature pattern was more stable and closer to the SOP standard ($p=0.016$). Humidity increased significantly after the implementation of IoT ($p=0.000$). Noise fluctuated, decreasing but increasing on average ($p=0.003$) due to the influence of automatic fans. Wind speed decreased significantly ($p=0.001$) and became more controllable through the implementation of a Variable Frequency Drive (VFD). O_2 levels showed an upward trend, while CO_2 decreased significantly to below the safe threshold of <3000 ppm ($p<0.001$). NH_3 showed signs of a decrease. Performance parameters showed a marked improvement, with mortality decreasing significantly ($p=0.005$), depletion reduced from below 5% to 3% ($p<0.01$), and body weight increasing significantly from 846.28 g to 895.43 g ($p<0.05$). The Daily Gain (DG) value ($p > 0.05$) was higher before IoT but more stable after IoT was implemented. FCR remained efficient ($p>0.05$), and the Performance Index (PI) increased from 360.7 to 414.2, although not significantly ($p>0.05$). Monitoring of electricity consumption through the smart metering system showed a trend towards efficiency, in line with the adaptive VFD-based fan control system that responds to environmental conditions. The System Usability Scale (SUS) assessment of the HMI system and recording website obtained a score of 68–72, which falls into the good usability category. The application of the IoT system has proven to be able to improve the stability of the microclimate in the coop, improve the growth performance of broiler chickens, and reduce potential operational energy costs. The implementation of this technology contributes to increasing production efficiency and the competitiveness of modern broiler farms in a sustainable manner.

Keywords: Internet of Things, Closed House, Broiler Chickens, Feed Efficiency, Production Index