RANCANG BANGUN SISTEM PENENTUAN KELAYAKAN KUALITAS AIR MINUM MENGGUNAKAN LOGIKA *FUZZY* BERBASIS IOT PORTABEL UNTUK PEMETAAN SPASIAL

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ABSTRAK

Ketersediaan air minum yang aman merupakan kebutuhan esensial, namun pemantauan kualitas air secara konvensional seringkali memakan waktu dan kurang memberikan informasi sebaran spasial secara real-time. Penelitian ini bertujuan untuk merancang dan membangun sistem *Internet of Things* (IoT) portabel guna menentukan kelayakan kualitas air minum berdasarkan pemetaan spasial. Perangkat keras dibangun menggunakan mikrokontroler ESP32 yang diintegrasikan dengan sensor pH, TDS, kekeruhan (*turbidity*), suhu (DS18B20), dan modul GPS U-Blox M8N. Pengambilan data di lapangan menggunakan metode *block averaging* selama 50 detik, di mana data rata-rata beserta titik koordinat spasial dikirim ke *Firebase Realtime Database* atau disimpan sementara ke memori *SD Card* saat *offline*. Penentuan kelayakan air ("Layak", "Perlu Perlakuan", "Tidak Layak") diproses secara lokal pada mikrokontroler menggunakan algoritma Logika *Fuzzy Mamdani*. Hasil pengujian menunjukkan bahwa seluruh sensor dan subsistem berfungsi dengan tingkat akurasi tinggi setelah dikalibrasi. Evaluasi klasifikasi algoritma fuzzy menggunakan *Confusion Matrix* terhadap kriteria standar baku mutu fisik dan kimia (Permenkes No. 492/2010 dan PP No. 82 Tahun 2001) menghasilkan tingkat akurasi komputasi sebesar 95.83%. Sistem ini berhasil mengimplementasikan pemetaan spasial kualitas air sebagai sistem deteksi dini yang andal, dengan batasan bahwa sistem ini tidak mencakup pengujian parameter biologis air.

Kata Kunci: *Internet of Things*, Kualitas Air Minum, Logika *Fuzzy Mamdani*, Pemetaan Spasial, ESP32.

DESIGN AND DEVELOPMENT OF A PORTABLE IOT-BASED DRINKING WATER QUALITY FEASIBILITY DETERMINATION SYSTEM USING FUZZY LOGIC FOR SPATIAL MAPPING

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ABSTRACT

The availability of safe drinking water is an essential need, yet conventional water quality monitoring is often time-consuming and lacks real-time spatial distribution information. This study aims to design and develop a portable Internet of Things (IoT) system to determine the feasibility of drinking water quality based on spatial mapping. The hardware was built using an ESP32 microcontroller integrated with pH, TDS, turbidity, and temperature (DS18B20) sensors, alongside a U-Blox M8N GPS module. To enhance the precision of analog data acquisition, the system was optimized by adding a 16-bit external Analog-to-Digital Converter (ADC) ADS1115, decoupling capacitors, and a voltage divider circuit. Field data collection utilized a 500-second block averaging method, where the averaged data and spatial coordinates were transmitted to the Firebase Realtime Database or temporarily stored on an SD Card when offline. The water feasibility determination ("Feasible", "Needs Treatment", "Unfeasible") is processed locally on the microcontroller using the Fuzzy Mamdani Logic algorithm. Test results indicated that all sensors and subsystems functioned with high accuracy after calibration. The classification evaluation of the fuzzy algorithm using a Confusion Matrix against physical and chemical quality standards (Permenkes No. 492/2010 and PP No. 82/2001) yielded a computational accuracy of 95.83%. This system successfully implemented spatial mapping of water quality as a reliable early warning system, with the limitation that it does not cover biological parameter testing.

Keywords: *Internet of Things, Drinking Water Quality, Fuzzy Mamdani Logic, Spatial Mapping, ESP32.*