ABSTRAK

Lahan gambut merupakan ekosistem yang rentan mengalami kerusakan dan kebakaran, terutama akibat penurunan tinggi muka air yang tidak terpantau secara berkelanjutan. Upaya mitigasi risiko kebakaran di wilayah ini membutuhkan sistem pemantauan lingkungan yang mampu memberikan peringatan dini secara *real-time* dan mencakup area yang sulit dijangkau. Keterbatasan infrastruktur dan jaringan telekomunikasi di wilayah gambut juga menjadi tantangan tersendiri dalam penyediaan sistem berbasis teknologi secara menyeluruh. Untuk menjawab tantangan tersebut, dibutuhkan pendekatan yang tidak hanya mengandalkan sensor otomatis, tetapi juga melibatkan partisipasi masyarakat lokal sebagai bagian dari proses pemantauan [1], [2].

Penelitian ini bertujuan untuk merancang dan mengimplementasikan sistem peringatan dini untuk pemantauan tinggi muka air di lahan gambut dengan pendekatan *hybrid* yang mengintegrasikan teknologi *Internet of Things* (*IoT*) dan pelibatan masyarakat melalui konsep *human-as-sensor*.

Metode yang digunakan dalam penelitian ini mengacu pada pendekatan *Design Science Research* (DSR), yang terdiri dari tiga tahapan utama: identifikasi masalah, pengembangan, serta evaluasi. Sistem dirancang menggunakan pemodelan *Unified Modeling Language* (UML), dikembangkan dengan mikrokontroler ESP32, sensor ultrasonic JSN-SR04T-2.0 dan DHT22, serta modul komunikasi *LoRa*. Sistem informasi dibangun dalam bentuk *dashboard* berbasis web menggunakan PHP dan MySQL, serta dilengkapi formulir pelaporan online dengan Kode QR untuk pelibatan masyarakat.

Hasil penelitian menunjukkan bahwa sistem yang dikembangkan dapat berjalan dengan baik dan diterima oleh pengguna. Berdasarkan pengujian *User Acceptance Testing* (UAT) terhadap 15 responden, sistem memperoleh tingkat penerimaan dalam kategori *baik* dengan nilai rata-rata 72,27%. Evaluasi berdasarkan *Digital Divide Theory* juga menunjukkan bahwa mayoritas responden memiliki akses perangkat dan keterhubungan digital yang memadai, serta kesiapan untuk berpartisipasi dalam pelaporan lingkungan. Sistem ini dinilai memiliki potensi untuk mendukung upaya pemantauan dan mitigasi risiko kebakaran lahan gambut secara partisipatif dan berkelanjutan.

Kata Kunci : ***Sistem peringatan dini, lahan gambut, Internet of Things (IoT), human-as-sensor, partisipasi masyarakat, UAT, Digital Divide Theory.***

ABSTRACT

Peatland ecosystems are critically vulnerable to degradation and fires, largely due to unmonitored and persistent declines in their water levels. Effective fire risk mitigation in these areas necessitates the implementation of robust environmental monitoring systems capable of delivering real-time early warnings, particularly in geographically challenging and remote locales. A significant impediment to the comprehensive deployment of technology-driven systems in peatland regions stems from existing limitations in infrastructure and telecommunication networks. Consequently, a holistic technological solution must integrate automated sensor capabilities with the active participation of local communities in the monitoring process [1], [2].

This research directly addresses this pressing need through the design and implementation of an early warning system specifically tailored for peatland water level monitoring. The system employs a hybrid approach, strategically combining *Internet of Things* (IoT) technology with the innovative human-as-sensor paradigm. This synergistic integration aims to harness the inherent strengths of both automated data acquisition and localized, *human-as-sensor* observational insights.

The methodological framework underpinning this study adheres to the principles of *Design Science Research* (DSR). This systematic approach encompasses three distinct yet sequential phases: problem identification, development, and evaluation. The system's architectural blueprint was meticulously defined utilizing *Unified Modeling Language* (UML). For its practical realization, an ESP32 microcontroller was selected as the core processing unit, interfaced with JSN-SR04T-2.0 and DHT22 sensors to ensure accurate environmental data acquisition, and augmented by a LoRa communication module to facilitate robust, long-range wireless data transmission. The user interface of the information system is presented as a web-based dashboard, developed using PHP and MySQL, and is further enhanced by an online reporting mechanism accessible via QR codes to actively facilitate and streamline community engagement.

The empirical findings unequivocally demonstrate the system's robust functionality and its favorable reception among its intended users. A comprehensive *User Acceptance Testing* (UAT), conducted with a cohort of 15 respondents, yielded a commendable average acceptance score of 72.27%, positioning the system's reception as highly satisfactory. Furthermore, an evaluative analysis, informed by *Digital Divide Theory,* indicated that the majority of respondents possess adequate access to digital devices and reliable connectivity, coupled with a discernible willingness to participate in environmental reporting initiatives. Collectively, these findings underscore the substantial potential of this developed system to meaningfully contribute to participatory and sustainable efforts in the monitoring and mitigation of peatland fire risks.**Keyword :** ***Early warning system, peatland, Internet of Things (IoT), human-as-sensor, community participation, User Acceptance Testing (UAT), Digital Divide Theory***