

ABSTRACT

Congestion at toll gates due to manual systems is a major problem in Indonesia. The surge in vehicles exacerbates inefficiencies and negatively impacts the economy and the environment. To address these challenges, this research focuses on developing an automatic vehicle identification system based on UHF Radio Frequency Identification (RFID).

This toll road RFID system is designed with integrated hardware and software. The hardware includes a passive UHF RFID tag antenna design and an RFD182-USB RFID reader connected to a NodeMCU ESP8266 microcontroller, sensors, an LCD, a buzzer, and a servo. Data is read and sent in real time to a Firebase cloud server. A SpeedPay mobile application and an admin website were developed for user interaction and data management, including registration, top-up, history, and CRUD features for admin and vehicle data.

Test results demonstrated the system's effectiveness. The tag antenna, despite differences between simulation and fabrication, remained functional. The reader was able to detect tags consistently from various angles, and signal simulations demonstrated the advantages of BPSK modulation. The application and website functioned optimally with real-time data integration and high user satisfaction (QoE score of 5). The system achieved 99% uptime, demonstrating good service stability and availability. Despite its limited physical reading range (8 cm), the system demonstrates potential for optimizing toll transactions.

Keywords: RFID, UHF, Toll Road, Firebase, NodeMCU, Android Studio, CodeIgniter, Simulation, Quality of Experience (QoE).