ABSTRAK

Peminat transportasi kereta api di Indonesia sangat tinggi, sehingga keamanan dan kenyamanan menjadi prioritas. Salah satu tindakan *preventive maintenance* adalah memantau vibrasi kereta api menggunakan sensor *Accelerometer*. Penelitian ini menggunakan metode eksperimen perancangan untuk mengetahui pengaruh variabel terhadap hasil. Desain *software* menampilkan visualisasi grafik dan tabel data vibrasi dari kereta bogie *hybrid* PNM di website, yang dapat diunduh dalam format *csv, excel*, dan *pdf*. Desain UI menggunakan Figma, dan pengembangan *website* menggunakan VS Code dengan HTML, PHP, dan JavaScript. *Software* ini berhasil menampilkan visualisasi nilai vibrasi serta data yang tersimpan di *database*. Pengujian *alpha* menunjukkan semua fitur dan *interface* berjalan sesuai perancangan awal, dibuktikan dengan 49 item uji menggunakan metode *black box* yang berhasil. Desain *software* berbasis IoT dilakukan dengan pembuatan topik MQTT untuk *Hardware* 1 dan *Hardware* 2. Data vibrasi ditampilkan di *website* dan disimpan di *database*. Pengujian menunjukkan pengaturan *delay* optimal adalah 1000ms, dengan rata-rata ping jaringan 35 ms, dan *packet loss* sebesar 20,7% pada Hardware 1 dan 22,9% pada Hardware 2. Pengaturan ini optimal karena seimbang antara jumlah data yang dicatat dan toleransi *packet loss*, yang berada dalam rentang 15-24% sesuai standar TIPHON. Pengujian vibrasi pada bogie kereta *hybrid* menunjukkan rata-rata vibrasi 1,16 m/s^2 (*Hardware* 1) dan 0,79 m/s^2 *(Hardware* 2) di lintasan lurus, 4,93 m/s^2 (*Hardware 1*) dan 2,18 m/s^2 (*Hardware* 2) di tikungan, serta 0,76 m/s^2 (*Hardware* 1) dan 1,10 m/s^2 (*Hardware* 2) di jembatan. Hasil ini menunjukkan bahwa kondisi lintasan sangat memengaruhi percepatan dan stabilitas kereta *hybrid*. Analisis ini penting untuk perbaikan desain lintasan dan pengaturan kecepatan demi stabilitas dan kenyamanan.

Kata kunci: visualisasi data*, alpha testing, delay, packet loss.*

ABSTRACT

Train transportation enthusiasts in Indonesia are very high, so safety and comfort are a priority. One of the preventive maintenance actions is to monitor train vibrations using an Accelerometer sensor. This research uses the design experiment method to determine the effect of variables on the results. The software design displays visualization of graphs and tables of vibration data from PNM hybrid bogie trains on the website, which can be downloaded in csv, excel, and pdf formats. UI design uses Figma, and website development uses VS Code with HTML, PHP, and JavaScript. This software successfully displays visualization of vibration values and data stored in the database. Alpha testing shows that all features and interfaces run according to the initial design, as evidenced by 49 test items using the successful black box method. IoT-based software design is done by creating MQTT topics for Hardware 1 and Hardware 2. Vibration data is displayed on the website and stored in the database. Tests show that the optimal delay setting is 1000ms, with an average network ping of 35 ms, and packet loss of 20.7% on Hardware 1 and 22.9% on Hardware 2. This setting is optimal because it is balanced between the amount of data logged and the packet loss tolerance, which is within the range of 15-24% according to the TIPHON standard. Vibration testing on the hybrid train bogie shows average vibrations of 1.16 m/s^2 (Hardware 1) and 0.79 m/s^2 (Hardware 2) on straight tracks, 4.93 m/s^2 (Hardware 1) and 2.18 m/s^2 (Hardware 2) on curves, and 0.76 m/s^2 (Hardware 1) and 1.10 m/s^2 (Hardware 2) on bridges. These results show that track conditions greatly affect the acceleration and stability of hybrid trains. This analysis is important for improving track design and speed regulation for stability and comfort.

Keywords: *data visualization, alpha testing, delay, packet loss.*