

ABSTRAK

Pengelolaan sampah di Kota Yogyakarta menghadapi tantangan berupa peningkatan volume sampah dan kebutuhan perencanaan rute pengangkutan yang lebih efisien. Proses pengangkutan sampah yang masih bersifat reaktif berpotensi menyebabkan ketidakseimbangan pelayanan antar Tempat Penampungan Sementara (TPS), sehingga diperlukan pendekatan yang mampu mengantisipasi kebutuhan pengangkutan berdasarkan prediksi volume sampah. Penelitian ini bertujuan mengembangkan sistem rekomendasi optimasi rute armada pengangkutan sampah yang mengintegrasikan prediksi volume sampah dan optimasi rute kendaraan untuk mendukung pengambilan keputusan operasional.

Prediksi volume sampah dilakukan menggunakan metode *Seasonal Autoregressive Integrated Moving Average (SARIMA)* berdasarkan data historis volume sampah pada masing-masing kecamatan di Kota Yogyakarta. Hasil prediksi kemudian digunakan sebagai dasar pembentukan nilai demand pada proses optimasi rute menggunakan pendekatan *Capacitated Vehicle Routing Problem (CVRP)* berbasis *Google OR-Tools*. Metode penelitian meliputi pengumpulan data, *preprocessing* data, pemodelan SARIMA, integrasi hasil prediksi ke dalam model CVRP, implementasi model pada aplikasi berbasis web sebagai media visualisasi, serta pengujian performa model prediksi dan optimasi rute.

Hasil evaluasi menunjukkan bahwa metode SARIMA mampu menghasilkan prediksi volume sampah dengan rata-rata nilai *Mean Absolute Percentage Error (MAPE)* sebesar 9,05%. Pengujian optimasi rute dilakukan pada 1.104 skenario simulasi dan menunjukkan bahwa pendekatan CVRP berbasis *Google OR-Tools* menghasilkan rata-rata total jarak tempuh sebesar 34,12 km, lebih rendah dibandingkan metode baseline *Nearest Neighbor* sebesar 107,58 km. Hasil tersebut menunjukkan peningkatan efisiensi rute sebesar 68,29% serta menghasilkan rute yang memenuhi constraint kapasitas kendaraan pada seluruh skenario pengujian. Penelitian ini menghasilkan model prediksi dan optimasi rute yang diimplementasikan pada aplikasi berbasis web sebagai media visualisasi dan penyajian hasil rekomendasi rute. Kontribusi penelitian terletak pada pemanfaatan hasil prediksi volume sampah sebagai masukan dalam proses optimasi rute kendaraan sehingga rekomendasi rute yang dihasilkan tidak hanya mempertimbangkan kondisi saat ini, tetapi juga kebutuhan pengangkutan berdasarkan prediksi timbunan sampah. Hasil penelitian menunjukkan bahwa integrasi SARIMA dan CVRP mampu mendukung perencanaan pengangkutan sampah yang lebih adaptif, efisien, dan berbasis data di Kota Yogyakarta.

Kata kunci— Prediksi Volume Sampah, *Seasonal Autoregressive Integrated Moving Average (SARIMA)*, *Capacitated Vehicle Routing Problem (CVRP)*, Optimasi Rute Armada.

ABSTRACT

Waste management in Yogyakarta City faces challenges in the form of increasing waste volumes and the need for more efficient transportation route planning. The reactive waste transportation process has the potential to cause imbalances in service between Temporary Storage Sites (TPS), necessitating an approach capable of anticipating transportation needs based on predicted waste volumes. This research aims to develop a recommendation system for optimizing waste transportation fleet routes that integrates waste volume predictions and vehicle route optimization to support operational decision-making.

Waste volume predictions were performed using the Seasonal Autoregressive Integrated Moving Average (SARIMA) method based on historical waste volume data for each sub-district in Yogyakarta City. The prediction results were then used as the basis for generating demand values in the route optimization process using the Capacitated Vehicle Routing Problem (CVRP) approach based on Google OR-Tools. The research methods included data collection, data preprocessing, SARIMA modeling, integration of the prediction results into the CVRP model, implementation of the model in a web-based application for visualization, and performance testing of the prediction and route optimization models.

Evaluation results showed that the SARIMA method was capable of producing waste volume predictions with an average Mean Absolute Percentage Error (MAPE) of 9.05%. Route optimization testing was conducted on 1,104 simulation scenarios and showed that the Google OR-Tools-based CVRP approach produced an average total distance traveled of 34.12 km, lower than the baseline Nearest Neighbor method of 107.58 km. These results indicate a 68.29% increase in route efficiency and a route that meets vehicle capacity constraints across all test scenarios. This research produces a route prediction and optimization model implemented in a web-based application for visualization and presentation of route recommendations. The research's contribution lies in utilizing waste volume predictions as input for the vehicle route optimization process, ensuring that the resulting route recommendations not only consider current conditions but also transportation needs based on predicted waste generation. The results demonstrate that the integration of SARIMA and CVRP can support more adaptive, efficient, and data-driven waste transportation planning in Yogyakarta City.

Keywords— Waste Volume Forecasting, Seasonal Autoregressive Integrated Moving Average (SARIMA), Capacitated Vehicle Routing Problem (CVRP), Vehicle Routing Optimization.