Optimasi Rute Pengiriman Barang pada Tahap Last-Mile dengan Sistem Truck-Drone menggunakan Metode Constrained DBSCAN dan Tabu Search = Goods Delivery Route Optimization at the Last-Mile Stage with Truck-Drone System using Constrained DBSCAN and Tabu Search Methods

Kezya Samantha Sherryn, author

Abstrak

Perkembangan teknologi memainkan peran penting dalam peningkatan jumlah pengguna e-commerce di Indonesia yang kemudian menyebabkan peningkatan signifikan dalam volume pengiriman paket. Namun, peningkatan ini juga menimbulkan masalah terkait emisi gas rumah kaca terutama pada tahap pengiriman terakhir yang sering melibatkan penggunaan kendaraan bermotor. Selain itu, terdapat pula kendala ketika tempat tujuan sulit dicapai dengan menggunaan kendaraan bermotor pada tahap pengiriman terakhir. Oleh karena itu, perlu dicari solusi yang tidak hanya mengurangi dampak lingkungan, namun juga dapat meningkatkan aksesibilitas pada tahap pengiriman terakhir. Penelitian ini mengintegrasikan penggunaan truk dan drone yang bertujuan untuk mengurangi emisi gas rumah kaca dan mengatasi kendala aksesibilitas dengan kemampuan drone. Metode yang digunakan melibatkan penerapan Constrained Density-Based Spatial Clustering of Applications with Noise (Constrained DBSCAN) untuk melakukan proses clustering terhadap data pelanggan dengan mempertimbangkan kendala jumlah drone yang tersedia dan daya jangkau drone serta penerapan Tabu Search untuk merancang rute pengiriman yang optimal dengan mempertimbangkan kendala time windows pada depot dan seluruh cluster. Implementasi kedua metode tersebut digunakan pada data 90 pelanggan. Constrained DBSCAN dapat mengurangi 63.16% jumlah cluster, mengurangi 69.61% total jarak tempuh rute, mengurangi 44.89% total waktu tempuh rute, dan penurunan 8.73% nilai fungsi objektif jika dibandingkan dengan yang diperoleh dari clustering secara intuitif.

.....Technological advancements play a pivotal role in the surge of e-commerce users in Indonesia, subsequently resulting in a substantial increase in parcel delivery volumes. However, this upswing poses challenges related to greenhouse gas emissions, particularly in the last-mile delivery stage that frequently relies on motorized vehicles. Additionally, difficulties arise when the destination is hard to reach using motorized vehicles during the final delivery stage. Hence, a solution is imperative, one that not only mitigates environmental impacts but also enhances accessibility in the last-mile delivery stage. This research integrates the use of trucks and drones with the aim of reducing greenhouse gas emissions and overcoming accessibility constraints through drone capabilities. The methodology employed involves the application of Constrained DBSCAN for clustering customer data, considering constraints such as the available number of drones and drone range. Tabu Search is then implemented to design optimal delivery routes, taking into account time window constraints at depots and across all clusters. Both methods are applied to data representing 90 customers. The implementation of these approaches shows promise in addressing the challenges posed by the last-mile delivery stage, offering a balanced solution that not only reduces environmental impact but also enhances efficiency in the delivery process. Constrained DBSCAN can decrease 63.16% of the number of clusters, decrease 69.61% of the total route distance, decrease 44.89% of

the total route time, and decrease 8.73% of the objective function value when compared to that derived from clustering with intuition.