

INTISARI

Pengelolaan sampah menjadi tantangan utama di banyak negara berkembang semenjak tingginya pertumbuhan penduduk perkotaan. Kota Tangerang merupakan satu kota dengan kepadatan penduduk tertinggi di Indonesia telah menghadapi disorganisasi sistem pengelolaan sampah yang ditangani oleh pemerintah. Penelitian ini bertujuan untuk membuat alternatif transportasi pembuangan sampah dengan memodelkan rute dan jumlah perjalanan. Merubah lokasi parkir kendaraan di setiap kelurahan menjadi ke TPA adalah langkah awal untuk mengurangi jarak yang tidak perlu. Kendaraan harus memulai dan mengakhiri aktivitas di TPA. Perhitungan jarak antara asal dan tujuan menggunakan Google API pada waktu keberangkatan tertentu dengan memasukkan data koordinat seperti longitude dan latitude. Aplikasi ini sekaligus menerapkan pendokumentasian jarak dan waktu pada 338 titik pengumpulan sampah. Hasil data dikompilasi dalam matriks jarak untuk menghubungkan tujuan terdekat antara titik pengumpulan. Kombinasi titik pengumpulan harus memenuhi persyaratan kapasitas, yaitu 6 m³. Terakhir, semua rute yang baru dipilih dan digabungkan menjadi beberapa perjalanan untuk setiap kendaraan. Rute baru ini menghasilkan bahwa beberapa dump truck dapat mengangkut sampah lebih dari 2 perjalanan. Dibandingkan dengan sistem saat ini, rencana pengumpulan baru dapat mencapai pengurangan (1) 8% dari total jarak pengangkutan; (2) 4% untuk waktu pengumpulan; (3) 31% untuk jumlah kendaraan yang digunakan, begitu juga perawatan, konsumsi bahan bakar dan biaya tenaga kerja pada porsi yang sama.

Konsumsi bahan bakar yang sebenarnya dihitung menggunakan persamaan dari Kementerian Pekerjaan Umum di Indonesia. Hasilnya adalah konsumsi bahan bakar saat ini berlebih 20% dari penggunaan di lapangan. Selain itu, rute baru dapat mengurangi 26% konsumsi dan biaya bahan bakar. Singkatnya, total biaya pengumpulan model optimasi yaitu untuk bahan bakar, pemeliharaan, dan tenaga kerja berkurang 31%.

Kesimpulannya, optimalisasi rute pengangkutan sampah di Tangerang sangat diperlukan untuk memperbesar porsi anggaran fasilitas daur ulang. Pemerintah Kota Tangerang dapat menggunakan model usulan ini sebagai rekomendasi pengangkutan sampah. Namun, model optimasi ini terbatas hanya untuk Kota Tangerang saat ini. Model ini dapat digunakan sebagai referensi apabila atribut-atribut tersebut tetap, termasuk lokasi, kapasitas, dan jumlah pengumpulan sampah; jumlah dan kapasitas maksimum kendaraan; dan jam kerja maksimal.

Kata kunci: biaya, jarak, konsumsi bahan bakar, GIS, optimasi, transportasi, pengumpulan sampah

ABSTRACT

Solid waste management has become a significant issue caused by the massive growth of the urban population in many developing countries. Indonesia is one of the largest populations in developing countries with a dense population. As one of Indonesia's highest density population cities, Tangerang City spent up to 76% of the Municipal Solid Waste Management (MSWM) budget on fuel and salary. In 2020, the total amount of solid waste collected was 1,248 m³ per day, twice the national average for the urban area (The Ministry of Environment and Forestry in Indonesia, 2020).

The Minister of Public Works Regulation Number 03/PRT/M/2013 mentions that the number of trips is made by considering the vehicle's efficiency and effectiveness and depending on the travel distance of each vehicle. The city put waste collection effort two trips in a day for each vehicle. The existing waste transportation management applies the same amount of fuel budget allocation except for the 23 farthest sub-districts. Therefore, many vehicles serve half the distance of others even though the budget allocation is the same in a day. Thus, the actual fuel consumption calculation is needed to compare the money lost on each trip. The research aims at proposing a development model for optimized solid waste disposal transportation system in Tangerang Municipality, Indonesia reduce the distance, the time, and the cost of the system. Therefore, the first step is decreasing unnecessary distance reconfiguring all of vehicle pools at the landfill area. The new optimized routes all and end the journey at the landfill.

Second, Google API was used to calculate the distance of OD pair at a particular departure time by inputting coordinate data such as longitude and latitude. The recording of distance and time was applied to 338 waste collection points in 104 sub-districts simultaneously. The distance data was used as an input in the distance matrix to seek the nearest destination between each point. The combination of collection points must meet the capacity requirement, which is 6 m³. Last, all of the newly selected routes are then combined into several trips for each vehicle. The new arrangement found that several dump trucks can travel more than 2 trips. Compared to the current system, the new collection plan can achieve a reduction of (1) 8 % distance driven; (2) 4 % for the collection time; (3) 31 % for the number of vehicles used, so does the maintenance, cost, labor cost at the same level.

The actual fuel consumption was calculated using the equations from the Ministry of Public Works in Indonesia. The data inputs are constant, parameter coefficients, average speed, average acceleration, average ramp, mean derivative, average degree turnover, the standard deviation of acceleration, and vehicle weight. The average speed is measured using the distance and travel time from Google API, while the vehicle weight is the sum of vehicle weight and the vehicle capacity. The Indonesian Ministry of Public Works and the Transportation Agency in Tangerang Municipality provide others data needed. The result is that current fuel consumption excess 20% more than it is supposed to be. Furthermore, the new route can reduce 26 % for the fuel consumption as the same as the fuel cost. To sum up, the total collection cost of the optimization model includes fuel cost, maintenance cost, and labor cost decrease by 31%.

In conclusion, optimizing the route of solid waste transportation in Tangerang is highly needed to allocate the reduction budget for recycling facilities. The Tangerang Municipality government can use this proposed model as a recommendation for current solid waste transportation. However, this optimization model is limited for the current situation in Tangerang Municipality. Using this model as a reference is possible as long as these attributes mentioned are fixed, including location, capacity, and the number of waste collections; maximum number and capacity of vehicles; and the maximum working hours.

Keywords : cost, distance, fuel consumption, GIS, optimization, transportation, waste collection.