ABSTRAK

Permasalahan pengelolaan sampah perkotaan merupakan salah satu tantangan utama dalam mewujudkan pembangunan kota berkelanjutan, termasuk di Daerah Istimewa Yogyakarta (DIY). Peningkatan jumlah penduduk dan aktivitas masyarakat setiap tahun menyebabkan volume timbulan sampah terus meningkat, sementara kapasitas Tempat Pemrosesan Akhir (TPA) semakin terbatas. Kondisi tersebut mendorong perlunya sistem pengelolaan sampah yang lebih efektif melalui pendekatan desentralisasi, salah satunya dengan pembangunan Tempat Pengolahan Sampah berbasis prinsip *Reduce, Reuse, Recycle* (TPS 3R). Keberadaan TPS 3R diharapkan mampu mengurangi volume sampah yang diangkut ke TPA, menekan biaya transportasi, serta meningkatkan efisiensi pengelolaan sampah di tingkat masyarakat. Namun, penentuan lokasi pembangunan TPS 3R memerlukan perencanaan yang matang karena harus mempertimbangkan keterbatasan anggaran, ketersediaan lahan, kapasitas fasilitas, serta kemampuan menjangkau permukiman penduduk secara optimal. Penelitian ini bertujuan menentukan lokasi dan alokasi TPS 3R yang optimal di wilayah DIY dengan memaksimalkan jumlah permukiman yang dapat dilayani tanpa melampaui batas anggaran yang tersedia. Penelitian menggunakan metode *Multi-Maximal Covering Location Model* (MMCLM) berbasis *binary integer programming* untuk mengoptimalkan pemilihan lokasi berdasarkan kapasitas lahan, radius pelayanan, kebutuhan minimum pelayanan penduduk, batas anggaran investasi, serta mempertimbangkan keberadaan TPS 3R eksisting guna menghindari duplikasi pembangunan. Data yang digunakan meliputi 200.560 titik permukiman penduduk sebagai *demand nodes*, 170 kandidat lokasi TPS 3R beserta luas lahannya, 33 TPS 3R eksisting, data timbulan dan komposisi sampah dari Sistem Informasi Pengelolaan Sampah Nasional (SIPSN), serta alokasi Anggaran Pendapatan dan Belanja Daerah (APBD) DIY sebesar Rp30.153.059.031,39 sebagai batas investasi maksimum. Hasil optimasi menunjukkan bahwa pada skenario pemanfaatan anggaran mendekati 100%, terpilih 17 lokasi TPS 3R baru yang terdiri atas sembilan lokasi di Kabupaten Bantul, lima lokasi di Kabupaten Kulon Progo, tiga lokasi di Kabupaten Sleman, dan satu lokasi di Kota Yogyakarta, sedangkan Kabupaten Gunung Kidul tidak memiliki lokasi yang terpilih. Total investasi yang dibutuhkan sebesar Rp29.985.239.786 atau 99,44% dari anggaran yang tersedia, dengan sisa anggaran sebesar Rp167.819.245. Solusi tersebut mampu melayani 38.125 titik permukiman atau 19,01% dari total *demand nodes* serta memiliki kapasitas pengelolaan sampah sebesar 171,36 ton per hari. Hasil penelitian menunjukkan bahwa metode MMCLM mampu menghasilkan rekomendasi lokasi TPS 3R yang efisien dalam pemanfaatan anggaran dan kapasitas pelayanan, sehingga dapat menjadi dasar pengambilan keputusan dalam perencanaan pembangunan infrastruktur pengelolaan sampah berbasis masyarakat yang lebih efektif, efisien, dan berkelanjutan.

Kata kunci: TPS 3R, optimasi lokasi, *Multi-Maximal Covering Location Model*, pengelolaan sampah, Daerah Istimewa Yogyakarta, *sustainable city*.

ABSTRACT

Urban solid waste management has become one of the major challenges in achieving sustainable urban development, including in the Special Region of Yogyakarta (DIY), Indonesia. The continuous growth of population and community activities has led to a significant increase in municipal solid waste generation, while the capacity of existing final disposal sites is becoming increasingly limited. This condition highlights the need for a more effective decentralized waste management system, one of which is the development of Waste Processing Facilities based on the Reduce, Reuse, Recycle (TPS 3R) concept. The implementation of TPS 3R is expected to reduce the amount of waste transported to final disposal sites, lower transportation costs, and improve the efficiency of community-based waste management. However, determining the optimal locations for TPS 3R facilities is a complex task, as it requires consideration of budget limitations, land availability, facility capacity, and the ability to maximize service coverage for residential areas. This study aims to determine the optimal locations and allocation of TPS 3R facilities in the Special Region of Yogyakarta by maximizing the number of residential settlements served without exceeding the available budget. The study employs the Multi-Maximal Covering Location Model (MMCLM) based on binary integer programming to optimize facility location selection by considering land capacity, service radius, minimum service requirements, investment budget constraints, and the existence of current TPS 3R facilities to avoid duplicate investments. The dataset consists of 200,560 residential settlement points as demand nodes, 170 candidate TPS 3R locations with their respective land areas, 33 existing TPS 3R facilities, municipal solid waste generation and composition data obtained from the National Waste Management Information System (SIPSN), and the Regional Government Budget (APBD) of the Special Region of Yogyakarta amounting to IDR 30,153,059,031.39 as the maximum investment limit. The optimization results indicate that, under a budget utilization scenario approaching 100%, 17 new TPS 3R facilities are selected, comprising nine locations in Bantul Regency, five in Kulon Progo Regency, three in Sleman Regency, and one in Yogyakarta City, while no facility is selected in Gunung Kidul Regency. The total investment required is IDR 29,985,239,786, representing 99.44% of the available budget, with a remaining budget of IDR 167,819,245. The proposed solution is capable of serving 38,125 residential settlement points (19.01% of the total demand nodes) with a waste processing capacity of 171.36 tons per day. These findings demonstrate that the MMCLM method provides an efficient solution for TPS 3R location planning in terms of budget utilization and service coverage, thereby supporting more effective, efficient, and sustainable community-based waste management infrastructure planning.

Keywords: *TPS 3R, location optimization, Multi-Maximal Covering Location Model, waste management, Special Region of Yogyakarta, sustainable city*.