Optimized Routing Model for Municipal Solid Waste (MSW) Transportation System Leveraging Real-Time Data

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The escalating population and urbanization have led to a surge in municipal solid waste (MSW), posing numerous challenges in MSW collection and transportation. Garbage trucks, pivotal in this process, consume roughly 10,000 gallons of diesel annually (rank 3rd in fuel consumption), contributing to greenhouse effect. Despite technology's utilization for MSW collection, more effective measures are needed to mitigate severe environmental issues. GAMA platform, therefore, was employed with multi-agent systems, GIS, and real-time data to create a simulation model for optimizing garbage truck routes, prioritizing time, and minimizing residual waste. The multi-agent system's flexibility, aided by agents' independent processing and task allocation, optimizes overall system performance. Various scenarios were built and tested in a dynamic virtual environment before applying optimization algorithms for MSW transportation in these situations. Testing was conducted at four progressively complex research areas. Choosing time as the objective function, in simple area, Bellman-Ford cut operating time by 37.4% versus traditional method, while Dijkstra achieved 37.2%. In the other three areas, Dijkstra outperformed, with efficiency proportional to complexity, achieving reductions of 37.4%, 41.7%, and 42% respectively. Moreover, time optimization helped minimize fuel usage in MSW collection. We continued integrating real-time traffic data and repeatedly testing Dijkstra, then applied this model to area 1's operation in three 10-day phases, resulting in 217 fewer operation hours and 1.022 tons less diesel usage. With its adaptability to diverse areas, especially complicated ones and independent operation with input data, this optimized model can effectively mitigate harmful emissions.

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