WasteMeter: AI-Driven Route Optimization in Waste Management for Pollution Prevention

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The total generation of solid waste in the US is 292.4 million tons/year, EPA (2024), and its processing requires the use of one of the least efficient vehicles on the road, the garbage truck, which averages 3 miles/gallon and is a big source of greenhouse gas emissions in the US. The US government set the climate change target of reducing GHG emissions by 61-66% for 2035. The present investigation proposes a smart system, WasteMeter, composed of three elements: a solar-powered monitoring device that calculates dumpsters fill levels using sensor data transmitted to a centralized database; a software engine that optimizes trash pickup routes using the TSP solver; and a webpage to publish system's findings. Statistical analyses were conducted to quantify the accuracy and reliability of the device, using 120 trials and two ANOVAs. WasteMeter proved to have an accuracy of 97%. With an upfront market cost of $127.60 and with no systems on the market that offer all its features, WasteMeter represents a 94.5% cost reduction compared to a market alternative at $2400. Simulations revealed that using WasteMeter improves waste collection efficiency by 8.9%, reduces 22.6 million tons of CO2 emissions annually, 12.95%/year in US alone. Using the Social Cost of Carbon (EPA, 2023), the financial cost associated with the impact of CO2 on humanity is $190 per ton of CO2. Implementing WasteMeter could potentially result in savings of approximately $4.3 billion in US annually by reducing the time of garbage trucks on the road through optimization of waste collection.

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