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From Blind Collection to Smart Routing: A Data-Driven Analysis of Waste Collection in Figueira da Foz

This study analyzes the waste collection operations of the municipality of Figueira da Foz, Portugal, using real operational data from February 2020 to April 2024. The objective is to evaluate and optimize the current system through four distinct scenarios. First, we establish a baseline by examining the existing system, which operates on fixed schedules and routes - a method commonly referred to as blind collection. In the second scenario, we automate collection frequency and routing by clustering containers according to their historical filling patterns, aiming to reduce inefficiencies and unnecessary trips. The third scenario simulates a fully sensorized system, where real-time data from all containers enables a highly dynamic and responsive routing process. Finally, we explore a partially sensorized network, where only selected containers are equipped with sensors. The data from these containers is used to infer the behavior of similar, non-sensorized containers within the same cluster. For each scenario, we solve a Vehicle Routing Problem with Profits (VRPP) to optimize collection routes and maximize efficiency. The results demonstrate that partial sensorization, combined with behavioral clustering, can significantly enhance operational performance and reduce costs, even without full sensor coverage.

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