Of rats and ~~garbagemen~~ sanitation workers[1]

Source: Wikipedia   Source: istockphoto.com

Optimizing the schedule of trash collection is a major challenge in any metropolitan area, including the borough of Manhattan in New York City. With many relatively narrow streets full of cars (parked and moving) and pedestrians on narrow sidewalks, getting that schedule right is particularly important. Plastic bags full of garbage are often left on sidewalks long before they are picked up by unionized sanitation workers (a team of two per garbage truck). These bags are unseemly, smelly, and sometimes a health hazard. They also increase the population of rats that chew through the plastic and feast on garbage. Your team is hired to provide strategic advice on improving the trash collection in Manhattan, accounting for contingencies and multiple objectives.

Some data, to help you get started: Overall, the five boroughs of New York City have more than 800,000 residential buildings, producing on average 24 million pounds of trash a day[2]. Currently, the New York City Department of Sanitation (DSNY) operates a fleet of approximately 2,230 general and 275 specialized trucks to collect both trash and recycling in the entire city. DSNY's standard collection truck holds about 12 tons of waste. An average trash bag is 15 to 30 pounds. Bags are placed "curbside" after 8pm the day before scheduled pickups, which happen at either 7am-8am or 6pm-7pm depending on the location. Each residential building in Manhattan should be serviced 2-3 times a week.

Your task is to formulate a comprehensive plan that addresses the following critical aspects:

(1) **Resource Allocation Strategy:** Develop a system to optimize the distribution and frequency of trash pickups across Manhattan's twelve DSNY-designated sanitation districts (MN1-MN12). You need to decide on characteristics of city blocks (or entire sanitation districts?) that should have more frequent (i.e., 3 times per week) trash pickups. Using this, approximate the number of trucks needed to serve each district. Can that number be significantly reduced by sharing trucks across sanitation districts?

(2) **Evaluating Effectiveness and Equity:** Come up with quantitative measures for the efficiency and fairness/equity of your recommended strategy. (The issues of equity are particularly important for districts with lower socio-economic indicators.) If the goals of efficiency and equity are not fully aligned, explore possible trade-offs between them.

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[1] The title of John Steinbeck's famous novel *Of Mice and Men* is a quote from Robert Burns on the futility of planning and strategyzing when the uncertainty is too great and limitations are too rigid. ("The best-laid schemes of mice and men go oft awry.") Hopefully, the plan of ridding the New York City of rats will be a bit likelier to succeed due to your team's contributions.

[2] Commercial businesses produce additional 20 million pounds of garbage a day in NYC, but it is picked up by private hauling companies rather than the Sanitation Department staff; so, we get to ignore this for the purposes of your model.

Address 1 or 2 additional topics from the following list:

(3) **Disruption Scenarios:** Analyze the robustness of your strategy against common disruptions such as vehicle breakdowns, severe weather, holidays, or unexpected spikes in waste production. How might these scenarios impact your service schedule, and how can your strategy adapt to maintain both efficiency and equity?

(4) **Rats Problem:** Investigate how the trash problem in different sanitation districts is correlated with the number of rats. How would your new trash collection strategy affect the rat population? Which areas should be designated for morning pickup vs evening pickup?

(5) **Bins instead of Bags:** NYC is in the process of switching from allowed trash bags on the curb to required bins with secure lids. Aside from helping to reduce the rat population, the bins are also preferable since retrofitted trucks can load them more efficiently, without putting so much strain on sanitation workers. As of right now, the use of bins is mandatory for businesses and voluntary for residential buildings, and those who use bins are allowed to put them on the curb 2 hours earlier (after 6pm the day before their pickup). But starting next week, the use of bins will also become mandatory for smaller buildings with 1-9 residential units. Across the entire NYC, this is 91% of all residential buildings and they house 41% of households – though in Manhattan both of these fractions are certainly lower. How will this new rule affect the population of rats and the number of garbage trucks needed in Manhattan?

Prepare a detailed report, accompanied by a one-page executive summary directed to the Head of Waste Management Division. Be sure to articulate your primary recommendations, potential benefits, and possible limitations of your approach. Refrain from contacting municipal offices, but feel free to utilize any available public data to support your analysis.

Additional datasets and resources.
(You are not required to use any of these! Focus on whatever is useful for *your* model.)

- NY Times on the history of the problem and the plans to expand the use of bins to all residential buildings.

- Historical performance data for Manhattan's sanitation districts.

- Federal census information and socio-economic data.

- Department of Sanitation's records of current trash pickup frequency.

- Demographic and socio-economic data for each city district from the NYC DCP.

- New York City Rat Heat Map

A Note from the Organizers: Given the breadth and granularity of relevant datasets, it is very easy to spend most of your time on data acquisition and processing, leaving insufficient time for the actual mathematical modeling and producing actionable recommendations. We urge you to avoid this pitfall and work on "spatially coarse-grained" models – i.e., without trying to incorporate block-level granularity or developing optimal pickup routes within each sanitation district. Block-level granularity would be a useful step for professional consultants, but requires a lot more time than we give you in this competition.