Standard Operating Procedure – to determine optimal distance between trash receptables in public spaces via a modelling approach supplemented with empirical validation

Objectives:

1. Find the optimal distance that minimizes both littering rates as well as overflowing trash, given a fixed budget
2. In achieving objective #1, explore how budget, bin size, collection frequency changes the optimal distance
3. Disney takes littering into consideration in their calculation of p\_litter as a function of distance. However, they did not investigate trash overflow

Empirical data collection

1. Consider a 1 km x 1 km area in downtown vs suburban Boston, Toronto, and City X
2. Location all the trash receptables in that area using street view on Google Maps, map them using ArcGIS, calculate shortest distance between them – can only consider “walkable” paths that humans would realistically traverse. Ideally consider different degrees of urbanness for each location (urban, suburban, rural) where average distance between trash receptacles is expected to be different
3. Plot histogram of the distances for each of the three cities (frequency vs m)
4. Go in person, find ten receptables, and take photos. Determine average amount of overflowing trash items around bin, and per 1 km2 or neighbourhood for that part of the city; measure 10 locations’ litter in 1 m x 1 m plot as well. Obtain average density of mismanaged waste/km2for urban and rural part of each of the three cities by averaging the n = 10 measurements for both types of MMW, and then summing the two together
   1. or, can extrapolate the average to entire neighbourhood area for both types of MMW, then sum together
5. Develop mathematical model. Consider fixed bin size and frequency of collection. Optimize distance between trash receptables on public sidewalks
   1. Use bin size for the specific city under consideration
   2. Use frequency of collection for the specific city under consideration
   3. Use the area’s specific budget for trash collection
6. Compare model to empirical data, do the results match observations
7. Then use model to tell us, for each location, what the average distance between bins *should be*, if it isn’t what it already is

Modelling notes

first figure out littering and cost model, consider finite amount of resources

then add additional complexity with the overflowing trash

search up how probability of littering is affected by distance online

consider a spawning function, that places people at a random distance from a trash bin

consider you have an annual budget of $X for a trash can, plus $Y for trash collection. every 3 days, you used up some amount of money. Have a cumulative cost function along with a cumulative litter function

“He continually researched activity in his park and found that keeping trash receptacles no more than 25 feet apart was the optimum distance to deter littering.” – [The Park Catalog](https://www.theparkcatalog.com/trash-receptacles-buyers-guide#:~:text=He%20continually%20researched%20activity%20in,optimum%20distance%20to%20deter%20littering.)

d <= 10 feet, p litter = 12%

d >= 30 feet, p litter = 30%

“Keep America Beautiful surveyed 130 public places and found that as the distance between commercial trash receptacles increased, so did the amount of litter. Most littering that the organization observed occurred far from any park trash cans, an average of 29 feet. Walt Disney set the standard for clean parks. By following his techniques and the guidelines from Keep America Beautiful, your facility can be just as clean as the Happiest Place on Earth. Space out your commercial trash receptacles using these”

A screenshot of a computer

Description automatically generated

“How Far Apart Should Park Trash Cans Be Installed Along Paths? At a minimum, space public park collections every 200-300 feet along recreation trails and key pedestrian routes through larger parks to always keep the next bin visible. In high-density urban areas like shopping districts, spacing collection bins every 40-75 feet ensures convenient access for proper litter discarding before pedestrians move out of range.” – [Furniture Leisure](https://www.furnitureleisure.com/strategic-placement-of-trash-cans-to-maximize-usage-and-cleanliness)

“The size of the waste receptacle should be related both to how much it is expected to be used and how frequently it will be emptied. A well-managed public space will always have smaller receptacles that are emptied often rather than one large receptacle that is not frequently emptied. In most areas, a 30 to 50 gallon container is adequate.” – [Project for Public Spaces](https://www.pps.org/article/wastereceptacles)

A lot of littering occurred at transition points and near public seating areas such as park benches and picnic tables. “Spacing is also vital when it comes to minimizing trash. Keep America Beautiful found the distance to the trash can at the time of disposal negatively impacts littering. As the distance to the nearest trash receptacle increases, so does littering. After observing people littering in public spaces, Keep America Beautiful found that the nearest trash receptacle was 29 feet away, on average. When people were within 10 feet of the receptacle, the litter rate decreased to 12%, whereas the litter rate was just over 20% when people were 21 to 30 feet from the trash can. The Walt Disney Company studied customers’ behaviour when it comes to the trash at entertainment parks and shopping areas and found that commercial trash receptacles must be within 30 steps to result in proper disposal.” - <https://playpowercanada.ca/blog/how-commercial-trash-cans-help-prevent-littering/>

“Keep America Beautiful conducted a study regarding the disposal behaviour of nearly 10,000 people from 10 different states in 130 different locations. They found all but two locations had litter present, despite the fact that 118 out of the 130 sites — 91% — had at least one trash can. Although litter behaviour relies heavily on individual, contextual demands, such as having plenty of trash cans readily available for public disposal, do play a role. Since the availability of trash receptacles has a positive effect on littering, consider stocking up on commercial garbage cans for your public park, recreational area, church or other places of worship, school or business to increase your efforts and stop litter from piling up.” – some proportion of individuals will litter regardless of spacing of trash receptacles. But the other way around is true as well - some proportion of individuals will never litter regardless of the circumstances

price range for a trash receptacle: $1500 - $4000

As of Jul 11, 2024, the average hourly pay for a Garbage Truck Driver in Boston is $19.82 an hour. While ZipRecruiter is seeing salaries as high as $31.34 and as low as $13.06, the majority of Garbage Truck Driver salaries currently range between $17.26 (25th percentile) to $25.05 (75th percentile) with top earners (90th percentile) making annually in Boston. – Zip Recruiter

<https://www.ziprecruiter.com/Salaries/Garbage-Truck-Driver-Salary-in-Boston,MA#:~:text=As%20of%20Jul%2011%2C%202024,Boston%20is%20%2419.82%20an%20hour>.

Most of ones in Cambridge are 150 gallons = 570 L, Big Belly, says Avi. <Insert references>

Water bottle volume, 500 mL: <https://www.dimensions.com/element/water-bottle-single-use#:~:text=The%20Single%2DUse%20Water%20Bottle,takeout%20and%20disposal%20after%20usage>.

Total length of sidewalk in Harvard Square, 4.0 km (Google Maps, 2024)