

STATUS REPORT 1

To: CrowdMark City Government

From: Optimizer's Inc.

Date: April 12th, 2025

Subject: Recent Updates

Our team at Optimizer's Inc. has been hard at work planning optimal locations to place supply stations. Despite many challenges with lack of brain cells and technology such as Excel and Python, our team understands the urgency of bringing supplies to victims of the sushi and spaghetti nightmare. We have pushed through to formulate a solution.

Problem Formulation

We first constructed an initial minimization problem for finding the optimal placement of one supply station, multiplying weights (populations) with distances as follows.

$$\min \sum_{i=1}^{24} p_i(|x_i - u| + |y_i - v|)$$

To turn the problem into a *linear program*, we introduced new variables and constraints, as follows.

$$\begin{aligned} & \min \sum_{i=1}^{24} p_i(\delta_{x_i} + \delta_{y_i}) \\ \text{s.t. } & x_i - u \leq \delta_{x_i} \quad \forall i \in 1, 2, \dots, 24 & p_i &= \text{population at } i\text{'th coordinate} \\ & -x_i + u \leq \delta_{x_i} \quad \forall i \in 1, 2, \dots, 24 & x_i &= \text{x-coordinate of neighborhood} \\ & y_i - v \leq \delta_{y_i} \quad \forall i \in 1, 2, \dots, 24 & y_i &= \text{y-coordinate of neighborhood} \\ & -y_i + v \leq \delta_{y_i} \quad \forall i \in 1, 2, \dots, 24 & u &= \text{x-coordinate of supply station} \\ & \delta_{x_i} + \delta_{y_i} \geq 1 \quad \forall i \in 1, 2, \dots, 24 & v &= \text{y-coordinate of supply station} \\ & x, y, u, v \in \mathbb{Z}, \quad x, y, u, v \geq 0 & \delta_{x_i} &= \text{auxiliary variable corresponding to } |x_i - u| \\ & & \delta_{y_i} &= \text{auxiliary variable corresponding to } |y_i - v| \end{aligned}$$

Through this, we constructed an integer problem to work with.

Problem Implementation & Solution

Our team wrote Python code to run and solve our problem formulated above. After importing data from the excel sheet (CrowdMarkData.xlsx), we initialized 50 variables. This includes two variables (u, v) for the optimizer to find an optimal location and $2 \times 24 = 48$ auxiliary variables for each absolute value component. Further details about the Python program design will be provided in the *Final Report*.

Results

Our team deduced that the best place to place a singular supply station is at the coordinate (14,9). This maximizes outreach to the highest population neighborhoods and minimizes distance to these neighborhoods.