YumPizza, a chain of delivery-only pizzerias, would like to serve the suburban pizza market.  
Their goal is to offer guaranteed delivery within 30 minutes. Assume that a pizza is ready for  
delivery 15 minutes from the time a call is received (this includes total baking time). There are 49 neighborhoods that YumPizza would like to serve in the region. For each neighborhood, you are given representative longitude and latitude coordinates and average weekly demand for pizza. YumPizza has identified 10 possible locations for their pizzerias. For each possible location, you are given longitude and latitude coordinates and monthly leasing cost. A distance matrix has been created between neighborhoods and candidate locations measured in minutes. See data in the tables below file for details.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Potential candidate locations, J** | | | |  |  |  |  |  |  |  |  |  |  |  |
| ***j*** | **Longitude** | **Latitude** | **Monthly lease, *fj*** | | |  |  |  |  |  |  |  |  |  |
| **A** | -87.92 | 42.10 | $2,800 |  |  |  |  |  |  |  |  |  |  |  |
| **B** | -88.00 | 42.40 | $2,200 |  |  |  |  |  |  |  |  |  |  |  |
| **C** | -87.70 | 42.05 | $2,200 |  |  |  |  |  |  |  |  |  |  |  |
| **D** | -88.20 | 42.20 | $2,200 |  |  |  |  |  |  |  |  |  |  |  |
| **E** | -88.10 | 42.30 | $2,200 |  |  |  |  |  |  |  |  |  |  |  |
| **F** | -87.78 | 42.15 | $2,500 |  |  |  |  |  |  |  |  |  |  |  |
| **G** | -88.00 | 42.01 | $2,000 |  |  |  |  |  |  |  |  |  |  |  |
| **H** | -87.98 | 42.19 | $3,000 |  |  |  |  |  |  |  |  |  |  |  |
| **I** | -87.95 | 42.25 | $2,500 |  |  |  |  |  |  |  |  |  |  |  |
| **J** | -88.20 | 42.08 | $2,300 |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  | **Distance matrix (measured in minutes), *dij*** | | | | | | | | |  |
| **Demand nodes (neighborhoods), I** | | | |  | Candidate locations | | | | | | | | |  |
| ***i*** | **Longitude** | **Latitude** | **Demand** |  | **A** | **B** | **C** | **D** | **E** | **F** | **G** | **H** | **I** | **J** |
| 1 | -87.80 | 42.03 | 200 |  | 9.7 | 29.2 | 7.1 | 30.0 | 28.0 | 8.6 | 13.8 | 16.7 | 18.5 | 27.8 |
| 2 | -88.06 | 42.42 | 200 |  | 23.7 | 4.1 | 35.3 | 17.8 | 8.5 | 26.5 | 28.2 | 16.7 | 13.6 | 25.1 |
| 3 | -87.89 | 42.04 | 200 |  | 4.7 | 26.0 | 12.9 | 24.2 | 23.2 | 10.6 | 8.1 | 12.0 | 15.1 | 21.8 |
| 4 | -88.32 | 42.24 | 200 |  | 29.5 | 25.0 | 45.0 | 9.0 | 16.0 | 38.1 | 27.4 | 23.9 | 25.8 | 13.9 |
| 5 | -88.09 | 42.19 | 200 |  | 13.3 | 15.5 | 28.6 | 7.7 | 7.4 | 21.5 | 14.0 | 7.3 | 10.3 | 11.0 |
| 6 | -88.34 | 42.16 | 200 |  | 29.3 | 28.7 | 44.8 | 10.0 | 19.1 | 38.7 | 25.7 | 24.8 | 27.6 | 11.2 |
| 7 | -87.71 | 42.07 | 200 |  | 14.7 | 30.1 | 1.8 | 35.0 | 31.1 | 7.1 | 20.6 | 20.4 | 20.6 | 33.9 |
| 8 | -87.83 | 42.01 | 200 |  | 8.8 | 29.3 | 9.4 | 28.7 | 27.3 | 10.2 | 11.7 | 16.0 | 18.5 | 26.0 |
| 9 | -88.02 | 42.28 | 200 |  | 14.3 | 8.2 | 27.2 | 13.7 | 5.7 | 18.8 | 18.8 | 7.1 | 5.3 | 18.7 |
| 10 | -88.41 | 42.18 | 125 |  | 34.4 | 32.4 | 49.9 | 14.8 | 23.2 | 43.7 | 30.7 | 29.7 | 32.3 | 16.1 |
| 11 | -87.73 | 42.10 | 125 |  | 12.9 | 27.5 | 4.4 | 32.9 | 28.7 | 4.5 | 19.5 | 18.1 | 18.0 | 32.2 |
| 12 | -87.83 | 42.13 | 125 |  | 6.5 | 21.9 | 10.6 | 25.9 | 21.9 | 3.8 | 14.3 | 11.1 | 11.6 | 25.7 |
| 13 | -88.26 | 42.10 | 125 |  | 23.7 | 27.4 | 39.1 | 8.0 | 17.6 | 33.6 | 19.3 | 20.2 | 23.9 | 4.7 |
| 14 | -87.95 | 42.29 | 125 |  | 13.1 | 8.4 | 24.0 | 18.0 | 10.1 | 15.3 | 19.4 | 7.2 | 2.6 | 22.2 |
| 15 | -88.11 | 42.36 | 125 |  | 21.9 | 7.9 | 35.1 | 12.6 | 4.0 | 26.7 | 25.1 | 14.6 | 13.1 | 20.2 |
| 16 | -87.94 | 42.10 | 125 |  | 1.5 | 21.4 | 17.0 | 19.2 | 17.8 | 11.8 | 7.1 | 6.8 | 10.7 | 17.9 |
| 17 | -87.95 | 42.13 | 125 |  | 2.8 | 18.9 | 17.9 | 18.1 | 15.7 | 11.6 | 9.2 | 4.5 | 8.2 | 17.8 |
| 18 | -88.08 | 42.02 | 125 |  | 12.2 | 26.5 | 26.3 | 14.7 | 19.1 | 22.4 | 5.6 | 13.0 | 18.0 | 9.1 |
| 19 | -87.76 | 42.13 | 125 |  | 11.4 | 24.8 | 7.1 | 30.8 | 26.2 | 1.8 | 18.8 | 15.8 | 15.4 | 30.7 |
| 20 | -87.94 | 42.20 | 125 |  | 6.9 | 14.6 | 19.2 | 18.3 | 13.3 | 11.2 | 13.8 | 3.4 | 3.7 | 20.0 |
| 21 | -88.23 | 42.22 | 125 |  | 23.1 | 20.3 | 38.6 | 2.6 | 10.7 | 31.6 | 21.6 | 17.4 | 19.6 | 9.9 |
| 22 | -88.13 | 42.16 | 125 |  | 14.9 | 18.8 | 30.5 | 5.7 | 9.9 | 24.0 | 13.6 | 10.2 | 13.8 | 7.4 |
| 23 | -88.27 | 42.34 | 125 |  | 29.5 | 19.4 | 44.4 | 10.9 | 12.4 | 36.5 | 29.6 | 22.8 | 23.2 | 18.6 |
| 24 | -87.84 | 42.25 | 125 |  | 11.9 | 15.1 | 16.9 | 25.2 | 18.4 | 8.1 | 20.1 | 10.9 | 7.7 | 27.6 |
| 25 | -87.76 | 42.03 | 125 |  | 12.3 | 30.7 | 4.3 | 32.8 | 30.2 | 8.7 | 16.8 | 19.0 | 20.4 | 30.7 |
| 26 | -87.98 | 42.09 | 125 |  | 4.4 | 21.6 | 19.7 | 16.9 | 16.7 | 14.7 | 5.5 | 6.8 | 11.5 | 15.0 |
| 27 | -87.84 | 42.45 | 125 |  | 24.9 | 11.7 | 29.4 | 30.4 | 20.8 | 21.2 | 32.5 | 20.9 | 15.9 | 35.8 |
| 28 | -87.91 | 42.36 | 125 |  | 18.1 | 6.4 | 26.2 | 22.7 | 13.5 | 17.4 | 25.0 | 13.1 | 8.2 | 27.7 |
| 29 | -87.73 | 42.00 | 125 |  | 14.7 | 33.1 | 3.7 | 35.2 | 32.7 | 10.6 | 18.7 | 21.5 | 22.8 | 32.9 |
| 30 | -88.04 | 42.12 | 125 |  | 8.1 | 19.4 | 23.7 | 12.6 | 13.1 | 17.7 | 8.1 | 5.7 | 10.6 | 11.7 |
| 31 | -88.03 | 42.35 | 125 |  | 18.7 | 4.5 | 30.8 | 15.2 | 5.5 | 22.2 | 23.3 | 11.6 | 8.8 | 21.6 |
| 32 | -88.29 | 42.04 | 125 |  | 25.6 | 31.7 | 40.5 | 12.5 | 22.0 | 35.8 | 19.9 | 23.3 | 27.4 | 6.6 |
| 33 | -87.68 | 42.05 | 125 |  | 16.9 | 32.8 | 1.3 | 37.3 | 33.8 | 9.8 | 22.2 | 22.9 | 23.2 | 35.9 |
| 34 | -87.80 | 42.18 | 75 |  | 10.3 | 20.4 | 11.5 | 27.8 | 22.3 | 2.7 | 18.4 | 12.7 | 11.4 | 28.7 |
| 35 | -87.94 | 42.07 | 75 |  | 2.6 | 23.5 | 16.3 | 20.5 | 19.7 | 12.2 | 5.9 | 8.9 | 12.7 | 18.3 |
| 36 | -88.01 | 42.00 | 75 |  | 9.1 | 27.4 | 21.6 | 19.0 | 21.5 | 18.8 | 0.8 | 12.8 | 17.5 | 14.2 |
| 37 | -88.02 | 42.08 | 75 |  | 7.1 | 22.4 | 22.1 | 15.1 | 16.4 | 17.3 | 4.8 | 8.0 | 12.9 | 12.4 |
| 38 | -87.81 | 42.07 | 75 |  | 8.0 | 26.2 | 7.5 | 28.5 | 25.6 | 5.6 | 14.0 | 14.4 | 15.7 | 27.1 |
| 39 | -88.14 | 42.27 | 75 |  | 19.5 | 13.4 | 34.2 | 6.2 | 3.7 | 26.5 | 20.6 | 12.6 | 13.5 | 13.7 |
| 40 | -87.78 | 42.04 | 75 |  | 10.6 | 29.4 | 5.6 | 31.1 | 28.6 | 7.9 | 15.3 | 17.4 | 18.9 | 29.1 |
| 41 | -87.85 | 42.17 | 75 |  | 7.0 | 19.1 | 13.1 | 24.5 | 19.7 | 4.8 | 15.3 | 9.4 | 9.0 | 25.2 |
| 42 | -87.83 | 42.36 | 75 |  | 19.0 | 11.8 | 23.3 | 27.7 | 18.9 | 15.0 | 26.8 | 15.9 | 11.2 | 31.9 |
| 43 | -88.16 | 42.39 | 75 |  | 26.3 | 11.2 | 39.7 | 13.6 | 7.8 | 31.3 | 28.7 | 19.0 | 17.7 | 21.8 |
| 44 | -88.10 | 42.48 | 75 |  | 29.1 | 8.7 | 40.5 | 20.8 | 12.6 | 31.7 | 33.3 | 21.9 | 18.9 | 28.7 |
| 45 | -88.22 | 42.20 | 75 |  | 21.8 | 20.6 | 37.3 | 1.4 | 10.9 | 30.5 | 20.0 | 16.4 | 19.0 | 8.3 |
| 46 | -87.85 | 42.28 | 75 |  | 13.4 | 13.5 | 18.8 | 25.0 | 17.5 | 10.0 | 21.4 | 11.4 | 7.4 | 28.0 |
| 47 | -87.81 | 42.20 | 75 |  | 10.3 | 18.9 | 13.0 | 26.8 | 21.0 | 4.2 | 18.6 | 11.9 | 10.1 | 28.1 |
| 48 | -87.86 | 42.33 | 75 |  | 16.1 | 11.1 | 21.9 | 25.2 | 16.8 | 13.2 | 23.9 | 12.9 | 8.2 | 29.1 |
| 49 | -88.21 | 42.34 | 75 |  | 26.0 | 15.5 | 40.6 | 9.4 | 8.3 | 32.6 | 26.9 | 19.1 | 19.2 | 17.6 |

Part I: YumPizza initially started to serve all customers without a budget constraint.  
• Solve for the optimal pizzeria locations using Excel. How many facilities do you need to cover  
all neighborhoods? What is the total cost?  
• What are your overall observations in your approach?

The given data are Distance matrix for demand and facilities (time taken to delivery from a facility to the demand location) and Monthly leasing cost with the latitude and longitude of the locations. Using the given data, the first limitation is applied – 15 minutes delivery time. Using “IF” formula with a Condition 1 – True, 0 – False. The possible delivery Distance Matrix was created. Furthermore, applying Excel Solver by implementing all the set covering constraints with the demand data and leasing cost data. By running the solver, it was determined that facilities B,D,F and G are the possible facilities for demand coverage with a total cost of $8900.

• Perform sensitivity analysis such as the marginal coverage of the very last facility location,  
the second to the last facility and so on.

Part II: YumPizza agrees that serving all customers may not be a realistic goal. Additionally,  
YumPizza can spend only $6, 000 per month for rent.  
• How would you suggest that YumPizza change their supply chain strategy? Specifically, what  
should they choose as an objective function and why?

YumPizza's rent budget is limited to $6,000 a month, therefore, using the maximal covering location problem (MCLP) model, which aims to maximize the number of covered customers subject to a budget restriction, is one method for doing this. Given the budgetary restriction, we would select the objective function to maximize the demand met. To ensure that the entire cost does not exceed $6,000 per month, we would also need to include the monthly cost of leasing as a restriction.

• Solve for the optimal pizzeria locations using Excel under the strategy and objective function  
proposed above. How much neighborhoods does YumPizza now serve? What is the total  
cost? What are your overall observations?  
• Compare with previous solution in Part I where all neighborhoods are covered. Comments.

While comparing Part II and Part I, though the data taken to solve is same the objective functions, constraints and limitations differ in both the cases. The total cost has dropped from $8900 to $5000; facilities open for delivery has also deceased from 4 to 2. This emphasizes how crucial it is to prioritize coverage and take budgetary constraints into account when making decisions about the supply chain