

The Cost of Delivering Small Orders

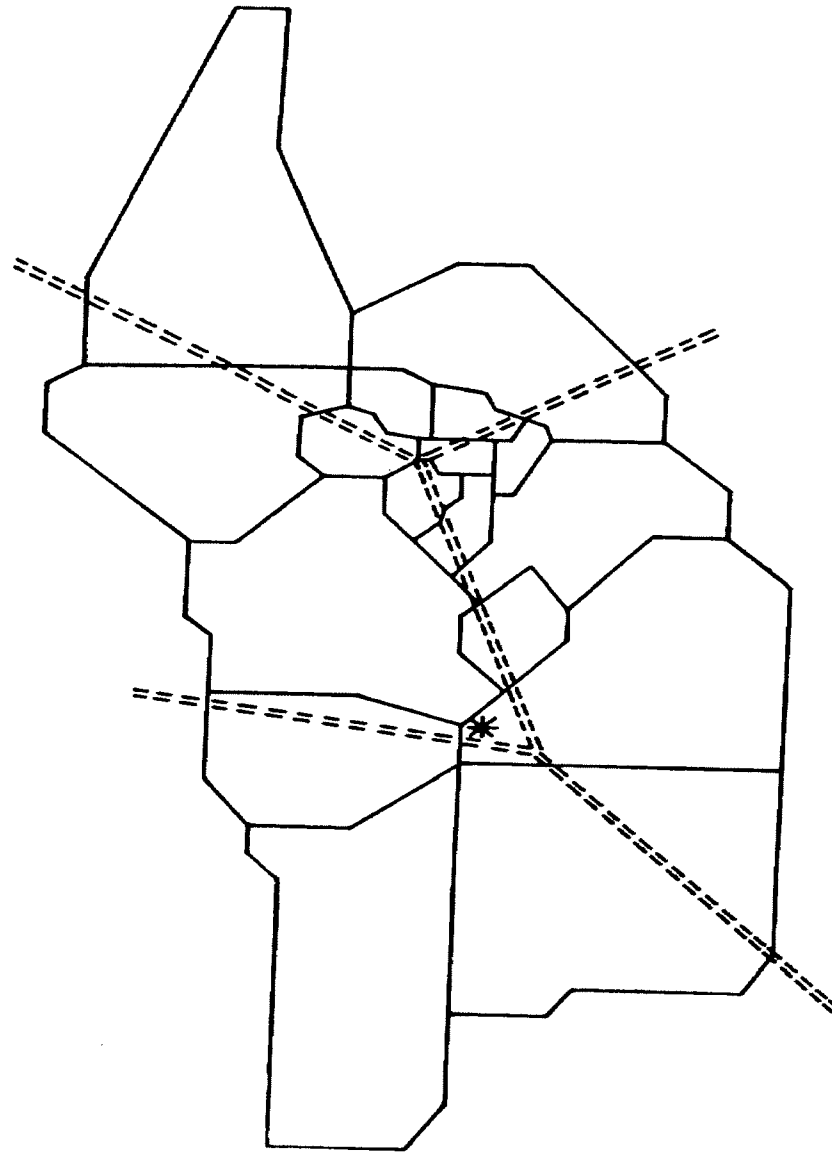
**(from Chapter 8 of *Operational Distribution Research*
by Mercer, Cantley, and Rand)**

Dr. Bruce Golden
August 31, 1999

Problem Description

- 300 Products
- Each depot serves an area of about 80 kilometers radius. The problem will focus on one of those depots (Figure 1)
- 20 Vehicles
 - 17 vehicles deliver to specific areas within the depot area
 - 3 vehicles deliver large loads anywhere within the depot area

Figure 1-Distribution of Grocery Supplies from the Storage Depots



Problem Description (Continued)

- Starting and Ending Points
 - Drivers Own The trucks
 - Drivers live far away from the central depot.
 - Starting and ending points could be different than the depot
- Delivery processing is done only for orders that include five or more boxes

Problem Description (Continued)

- Deliveries are not constrained by the amount of boxes. That is, deliveries of less than 5 boxes can occur
- One goal is to establish how to better balance production and inventory costs with distribution costs.
- Another goal is to make sure that all deliveries are profitable

Order Size Distributions for Deliveries and Sales

Order Size (Boxes)	Percentage of Deliveries (Orders)	Percentage of Sales (Boxes)
4 or less	7.5	0.5
9 or less	26.0	3.5
14 or less	38.5	8.5
19 or less	49.0	11.0
24 or less	55.0	14.0
49 or less	77.0	32.5
99 or less	89.0	52.0
249 or less	97.0	82.0

Order Size Distributions for Deliveries and Sales (Continued)

- Two important points to note from the table above
 - 25% of the orders were for less than 10 boxes but these represented less than 5% of sales
 - 50% of the orders are below 20 boxes and accounted for only 10% of sales

Order Size Distributions for Deliveries and Sales (Continued)

- These two points underline the importance of optimizing the distribution of small orders:
 - If small retailers were remotely located, increasing the minimum order threshold would almost halve the distribution costs and increase profitability
 - If small retailers are located near larger retailers, increasing the minimum order threshold would have an insignificant effect on distribution costs and profitability

The Simulation

- All orders for a period of time were extracted from the system and the depot manager was presented with batches on a day-to-day basis
- Three simulation scenarios were run:
 - Current conditions
 - Orders for only 10 boxes or more are processed
 - Orders for only 20 boxes or more are processed

The Simulation (Continued)

- The objective in running the scenarios is to find the least expensive way of operating the distribution network
- Current conditions are summarized in Figure 2
- Other simulation results are summarized in Figures 3, and 4.

Figure 2-Current Distribution of Calls per Week at Each Retailer

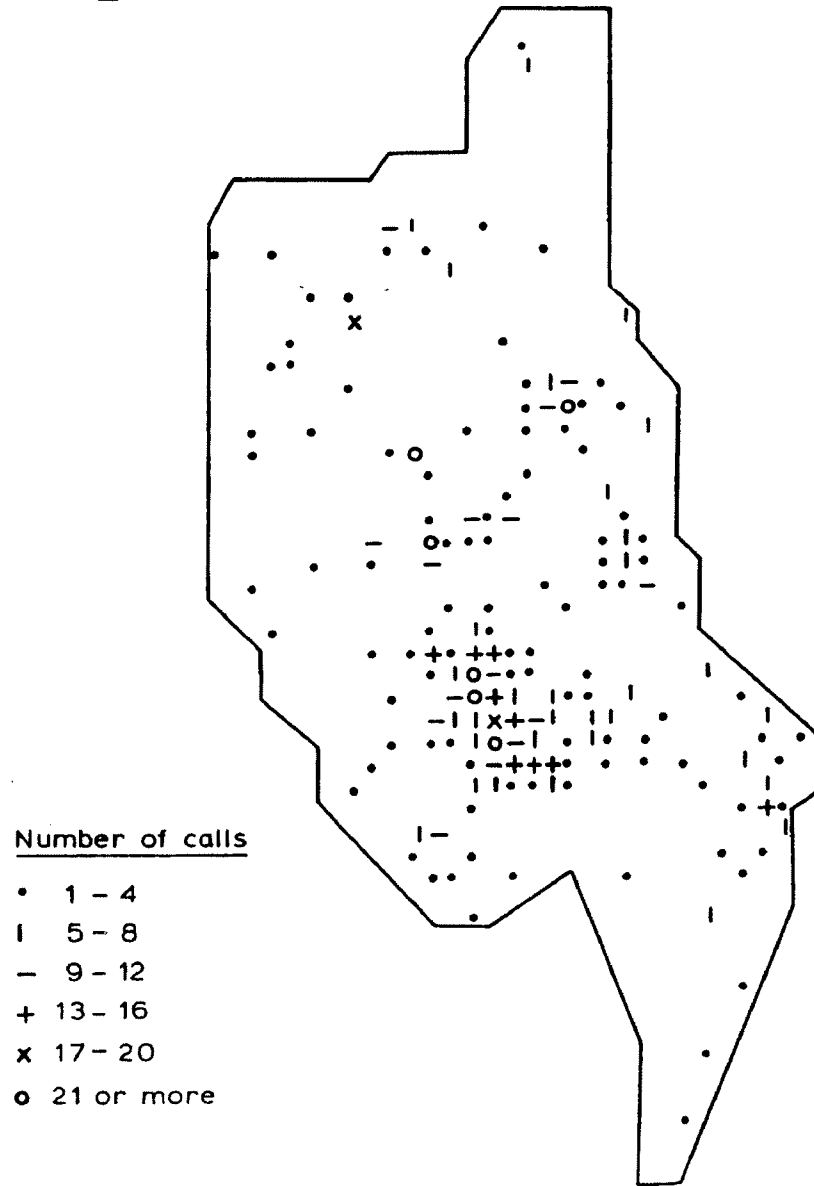


Figure 3-Simulation with Minimum Order Size of 10 Boxes

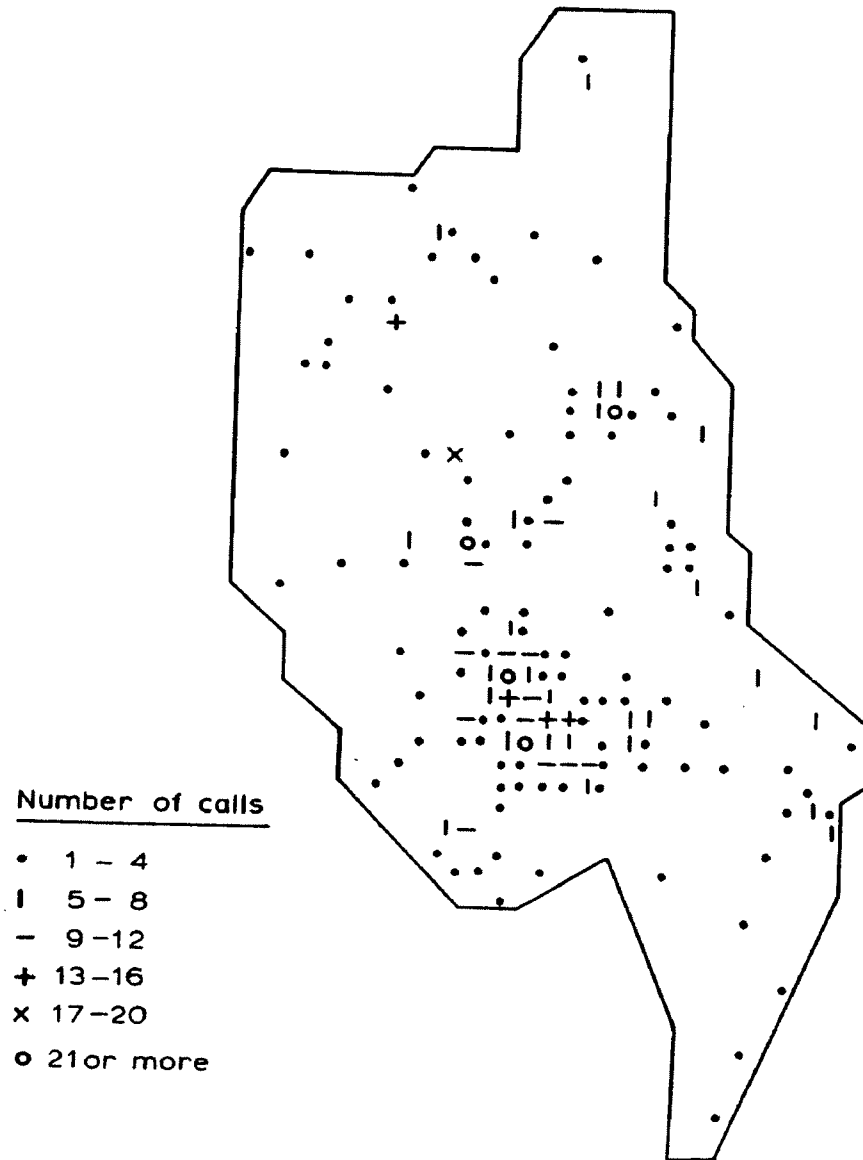
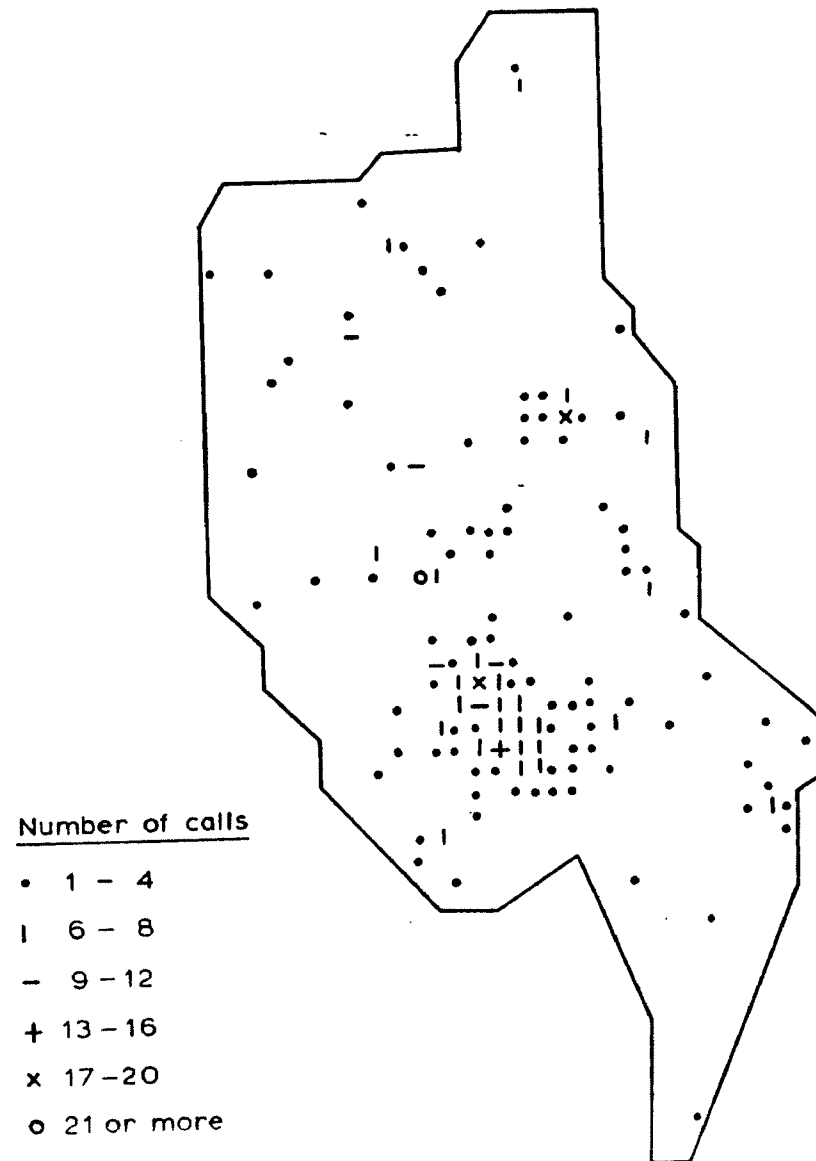


Figure 4-Simulation with Minimum Order Size of 20 Boxes



Results

- By increasing the minimum order size, vehicles deliver a smaller amount of larger orders
- Vehicle capacity becomes a critical constraint in the optimization analysis
- Overall, no significant benefits arise from raising the minimum customer order levels:
 - On average, retailers are located very close to each other
 - Small orders are placed from locations that are in close proximity to the locations from which large orders are placed
 - Cost savings arise from the use of fewer vehicles

Result Improvements

Results could be improved by:

- Limiting the lower ordering threshold
- Conditioning which orders below the threshold can be processed
 - Process all those orders that are placed by traditionally large customers
 - Process all those orders that are either within a certain distance radius or within delivery time range from any single major-order location
 - Process all those orders that are either within a certain distance radius or within delivery time range from a given number of major-order locations