Bakery Distribution System

Description

The bakery shop is part of a large food service chain that provides meals to a county school system and other customers. The bakery is responsible for delivering products to over 50 delivery points. The manger of this bakery shop is concerned with maintaining on time deliveries. The main reason for this concern is not the penalty he has to pay for late deliveries, but maintaining customer satisfaction. There are profits in minimizing the travel distance or maximizing load, but achieving timeliness at low cost does more than maximizing profits of the bakery shop.

The manager of the bakery shop is interested to build a decision support system that will help in scheduling delivery routes in such a way the customer satisfaction is guaranteed. Currently the manager is just guessing and physically testing the delivery routes. This makes the addition of new delivery routes expensive.

Excel Spreadsheets

1. The manager used the straight line distance between delivery points as an estimate of the travel time, since the travel time between delivery points has very small variance and is generally a small portion of total time required to complete a route. The following table presents the expected travel time as a function of distance traveled.

Straight-line Distance (miles)	Expected Travel Time (minutes)	Std. Deviation of Travel Time (minutes)
1.2	8	2
2.1	10	2.1
3.5	12	2.4
5.3	14	2.6
7.8	16	3
10	18	3.2

2. Loading and unloading times make up a big portion of the time required to complete a route. These times depend on the volume of products delivered. Cerate the following table that presents the expected loading and unloading time as function of the load size.

Load (Not to exceed)	Expected Unload Time (minutes)	Std. Deviation of Unload Time (minutes)
5	11	2
10	15	3
15	22	2
18	25	2

3. Create a spreadsheet that keeps the following information about each customer: identification number, name, address, telephone number, location (X and Y

coordinates), average amount of products shipped per week, frequency of weekly shipments and corresponding timetable, current balance, etc.
4. Create a spreadsheet that keeps the following information about the products produced in this bakery: identification number, name, unit cost, unit price, average production per week, etc.
5. Create a spreadsheet that keeps historical information about orders. This spreadsheet records: transaction identification number, customer identification number, order date, quantity ordered, expected delivery day and time, actual delivery day and time, amount paid, etc.

It is with high probability that the manager would reject unfamiliar or overly complicated solutions. For this reason we suggest the following nearest neighbor heuristic to pick routes and estimate completion times.

The Nearest Neighbor Heuristic

The heuristic works as follows:
1. Calculate the Euclidean distances between the bakery shop and each delivery point, as well as the distances between every two delivery points.
2. Starting with the bakery shop: (a) identify the nearest delivery point; (b) calculate the total of traveling and delivery time at this point; (c) check if the total time exceeds the promised delivery time. If it does not, continue the process of choosing the nearest neighbor. When the total time exceeds the promised delivery time, do not deliver to that node. The required delivery should be made by another route.

Simulation

There are uncertainties in the size of customer demand, the time it takes to load/unload the trucks and also the travel time. Therefore, we should perform a simulation study to assure reliability of the results. We run the simulation 100 times. Each time we randomly generate the customers' demand. Historical data about customer demand is used to identify the distribution of demand. In each run, the load/unload times and travel times will be calculated using the information provided in spreadsheets 1 and 2. For example, if the load does not exceed 5 units, the unload time is normal distributed with mean 11 and standard deviation 2.

The objective of this simulation study is to identify the probability the schedule we propose (the solution from the heuristic) will deliver the products on time.

User Interface

1. Create the following data entry forms for: customer information, customer demand, products, loading and unloading times, etc. These forms allow the user to add, update and delete information about the customers, customers' weekly demand, weekly production for each product, loading and unloading times, etc.
2. Create a form(s) that allow for an interactive implementation of the nearest neighbor heuristic.

3. Create a form that allows for an interactive implementation of the simulation study described above. For example, the user can choose the total number of simulation runs, the seed, etc.
4. Create a form that allows the user to change the order of delivery in the final solution, if s/he chooses to do so. Provide the user with the cost and expected delivery time of the new route

Reports

1. Report the weekly delivery schedule (as provided from the heuristic) that guarantees customer satisfaction. Provide the total delivery costs as well as expected delivery times.
2. Use histograms to identify the distribution of demand for each customer.
3. Report a summary of the results from the simulation analysis. Include in the results: the probability that the promised delivery times will be met by the schedule, expected delivery times and costs, etc.
4. Report detailed information about the customers that have payments due.
5. Report the following statistics:
    a. Actual weekly cost of distribution during the last 52 weeks.
    b. Actual revenues from sales in the last 52 weeks.
    c. Annual profits.

Source

Martin, E. *Centralized Bakery Reduces Distribution Costs Using Simulation*. Interfaces, Vol. 28: 4, pp 38-46, 1998.

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