



Location, location, location...

Choosing optimal locations for postal delivery depots

By Serge Galarneau

As postal organisations struggle to find ways to improve efficiency and profitability, the number and location of their delivery depots has come under increasing scrutiny. In France, for example, La Poste last year announced their intention to close 6,000 of 11,500 postal offices. Deciding which facilities to close, which ones to keep and where to build new ones is a very complex problem that must take multiple criteria into consideration.

A classical Operations Research problem

The field of *Operations Research* (OR) focuses on the application of mathematical techniques to optimise the use of limited resources. A textbook OR problem, known as the *Capacitated Facility Location Problem*, is illustrated in Figure 1. In this problem, we are given a set of potential facility locations and a set of customers.

There is a fixed cost for opening a facility, and a service cost associated to assigning a customer to a facility. Assuming each facility has a given supply capacity and each customer demands a certain quantity of service, we wish to accommodate all clients at a minimum total cost.

Manually finding a solution to this problem may be feasible when considering three or four locations. But when dealing with hundreds of existing and potential locations, it is simply too complex. Thankfully, several optimisation techniques have been developed to help quickly find optimal or near-optimal solutions to this type of problem. With some adaptations, these techniques can be used to evaluate and improve the locations of postal depots.

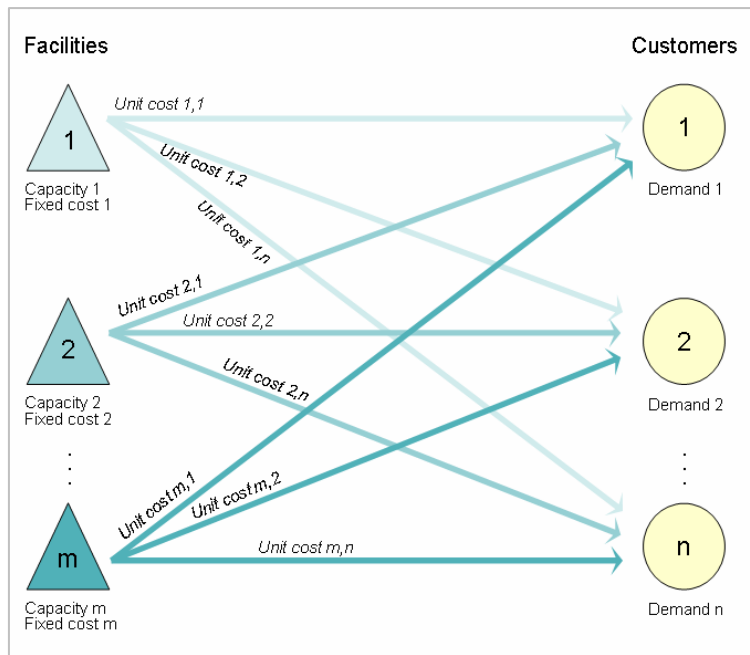


Figure 1 – The capacitated facility location problem.

Impacts on upstream and downstream routes

If we consider each existing postal delivery route as one customer, the existing optimisation techniques can help choose optimal locations for depots.

However, to make the problem more complex, each postal delivery depot is also supplied by routes feeding mail from the sort plant. Closing or moving a depot has an impact on these upstream routes, which may also need to be optimised as a result.

There is also a downstream impact, since each depot operates several delivery routes. When these delivery routes were planned, a certain duration was allocated for travel between the depot and their start and end points. If the depot is moved and/or some routes are assigned to a different depot, the travel times must be re-evaluated.

- More or less time may be required to travel to and from each delivery route.
- Delivery routes may need to be re-optimised to find start and end points that minimise travel times to and from new depot locations.
- In the worst cases, some delivery routes may become unfeasible because the updated travel times cause the overall route duration to exceed the maximum allowed by work rules. This may require a complete revision of the routes previously serviced by a given delivery depot.

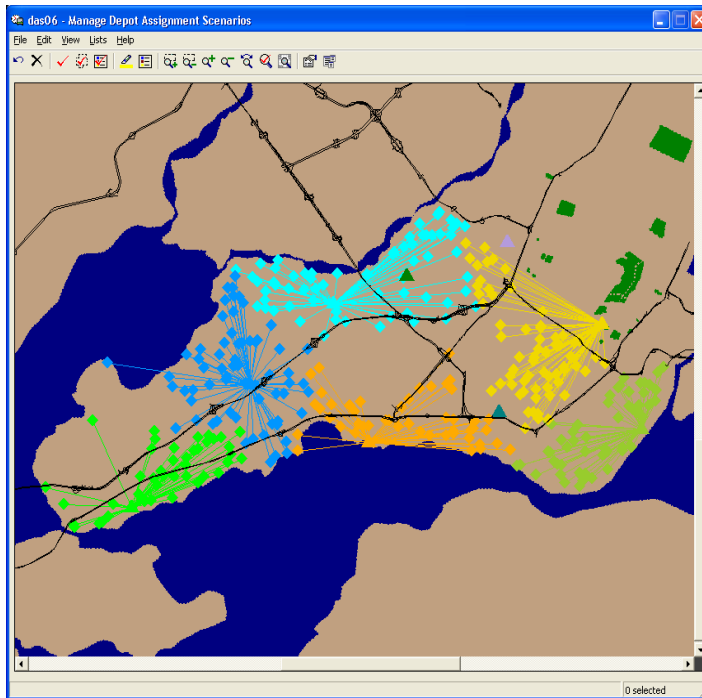


Figure 2 – Map showing route-to-depot assignments.

Impacts on travel modes

Another particularity of postal operations is that multiple travel modes are used, especially for deliveries, and moving depots may require a review of the travel modes that were previously in place. Such an evaluation should consider several additional criteria, including:

- What is the cost impact of using a one mode versus another to travel between the depot and the start and end points of a delivery route. Since travel speeds for each mode can vary significantly (e.g., bicycle versus car), this cost should include the hourly rate of the employee doing the travel?
- Will the mode of travel also be used to perform the mail delivery, thus further affecting the route duration?
- Does the delivery depot have constraints that restrict the number of units that can operate from it (e.g., limited parking space)?
- Do mail delivery work rules affect the choice of mode (e.g.: vehicles may be required if travel time by bicycle exceeds 20 minutes)?

Other criteria

To compare different solutions, the costs associated to the operation of each delivery depot also need to be considered. This assessment should include fixed costs such as taxes, electricity and heating, as well as the variable cost of processing mail items at each location.

The solutions to compare must also respect any physical constraints that limit the number of letter carriers that can work from each office.

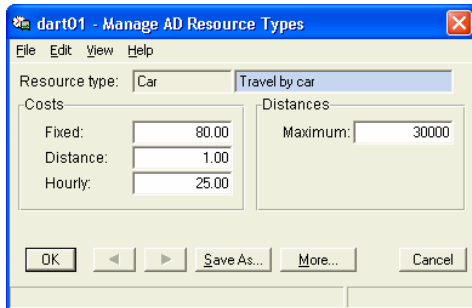


Figure 3 – Travel mode parameters to take into account.

Macro and micro modelling

As described here, the facility location problem is fairly complex and cannot be optimally resolved in a single step. The following approach would normally be used:

Macro-modelling

1. Identify potential locations and related criteria (available travel modes, capacity restrictions, fixed costs, etc.).
2. Based on existing routes and potential locations, solve the location problem.
3. After analysing the solution to step 2, review potential locations and/or some criteria.
4. Identify one or more scenarios that appear interesting, and subject them to a more detailed evaluation through micro modelling.

Micro-modelling

1. Optimise upstream and downstream routes for the chosen depot locations to evaluate the impact on operating costs.
2. Compare location scenarios based on total costs and other criteria.
3. Select the best scenario.

Locating new facilities

The task of finding optimal locations takes on another dimension if we also consider the possibility of building new facilities, as this introduces a theoretically infinite number of locations to choose from. Furthermore, potential new locations are affected by factors such as the capacity of neighbouring streets to handle larger vehicles, local zoning laws, etc. After taking these factors into account, you may find an optimal location that is not available. For instance, an excellent location to serve Paris may be in the middle of Place de l'étoile, but that spot is already taken.

To restrict the size of the problem and ensure the feasibility of new locations identified in the solution, it is advisable to create a short-list of potential locations and include them with existing locations for decision making.



Figure 4 – Excellent location, but already taken.

Conclusion

Optimising the number and location of collection and delivery depots is a multi-dimensional problem that can be addressed using facility location techniques that are specifically tailored to postal requirements. Proper optimisation requires that the routes supplying these depots and those delivering from them be optimised. Putting all the pieces together can lead to substantial and recurring cost savings.

While we used the delivery depot network as an example to describe the process of optimising facility locations, the same approach can be applied to optimising the location of collection and sorting facilities.