Business case 2 - The Post-Corona Post

1 Background

The pandemic has significantly accelerated the growth of e-commerce. With shops closed, many consumers did their shopping online. Post&L™ delivered a record number of 337 million parcels in 2020. Demand was highly variable, with peaks around the holiday periods and during the strictest phases of lockdown: on the busiest days, a whopping total of 1.7 million parcels were processed each day [4].
Post&L quickly made some changes to their delivery network to cope with the increased demand. With the pandemic over, things have mostly gone back to normal, however, some customer habits have permanently changed (like increased online shopping and increased working from home). Unfortunately, in recent years, profit for Post&L has sharply declined: down from 216 million in 2020 to just 56 million in 2024 [5].
This means that the distribution network of Post&L will likely need to be changed structurally. Therefore, Post&L is launching a pilot project to redesign the last-mile delivery system in Maastricht from scratch. A a consultancy company, staffed by freshly-graduated Business Analytics students, has been hired to prepare a detailed proposal on how this should be done. The following key questions must be addressed:

Figure 1: The logo of Post&L

1. What would the optimal network look like?
2. How much money would be saved yearly by using the optimal network compared to the current situation?
3. In addition to the usual delivery methods of at-home delivery and service point pick-up, Post&L is considering to add a third delivery option: *automated parcel lockers* (APLs). While a service point is usually located in a store (and can only be accessed during business hours), APLs can be placed almost anywhere (e.g. outside a gas station) and are accessible 24/7. Post&L is unsure of the business case for APLs (e.g., the cost compared to traditional service points, which customers are likely to prefer APLs, and in which neighbourhoods they are likely to be beneficial). You are asked to do desk research, come up with a model for how the network can be extended using APLs, and propose a second design for a network introducing APLs.

2 Service points

The delivery network of Post&L is built around service points. These comprise dedicated post offices, but also service desks in supermarkets and corner shops. A delivery driver either delivers the package directly to the customer's front door from the nearest service point, or if the customer is not home when the delivery attempt is made, the package is dropped off at the service point and the customer must collect it themselves.
Increasingly, retailers are offering the option for the customer to have the package dropped off directly at the service point, foregoing the delivery at home. This has many advantages: the customer does not have to be at home for the delivery and can pick the package up at their convenience when grocery shopping, it reduces congestion and pollution in the city, and it saves Post&L a significant amount of money as the last-mile delivery is the most expensive part of a parcel's journey.
These service points (and the locations thereof) are what this case revolves around. The case has been split into two *milestones*, which give a suggested order to tackle the issues of this case in, but it is important to completely understand both milestones before starting to work on the first one, because knowledge about the end goal is essential to make the right decisions in the first stages. This project is a lot of work, it is imperative to plan ahead, distribute the work among the team, and to start working on later milestones already before earlier ones are finished.

If you have any questions about the case, the problem owner, an executive from Post&L, will be present at all tutorial sessions (cleverly disguised to look like your tutor!).

3 Milestone 1: Data analysis, modelling and simulating customer behavior

Modelling Consumer Behavior. To be able to prepare Post&L's network for the post-pandemic situation, the first step is to obtain insight in customer behaviour. The most important factor in whether a customer decides to have a parcel delivered or pick it up themselves is the distance to the nearest service point. Many other factors play a role in this: whether the customer expects to be at home, their income level (richer customers tend to order more items from e-commerce retailers in general, and are also more likely to choose the more expensive at-home delivery option), their age, etc,...
Current data suggests that customers living within 200 meters of a service point (as measured by the shortest (walking) route from the service point to the customer's home) are most likely to pick up their packages themselves, with on average 80% of packages being collected by the customer and 20% being delivered. This drops off sharply though; a customer that lives more than 2.000 meters away essentially never collects their packages themselves.
To later be able to make informed decisions about the locations of service points and their capacities, the first milestone of the project is to be able to – given the (planned) locations of the service points – predict how many parcels will be picked up each day from each service point, and also estimate how many parcels will be delivered at home to consumers in the neighbourhood of each service point.

Modelling APLs. While Post&L is quite familiar with the pick-up and at-home delivery options, Automated Parcel Lockers (APLs) are a very new phenomenon, and Post&L does not yet have good information on these systems (e.g., their cost compared to service points, capacity, which customers are likely to prefer them). For the first milestone, you should investigate the possibility of using APLs, and propose to Post&L how they could be incorporated into the model (e.g., the cost compared to service points, which customers are likely to switch from either at-home or pick-up delivery to APL, how to model this).

Available Data. To help you get started, a basic data set is available. A map of Maastricht is available, comprising 8098 intersections and 10877 roads between them. Information about the names of the roads, geographical coordinates (x and y), lengths of roads (in meters), speed limits (in km/h), and function of road (e.g., highway or residential street) is available. The data has been extracted from Open Street Maps [1] using OARBench [2].
Furthermore, some data is available from a Geographic Information System (GIS) due to Statistics Netherlands (CBS) and the Kadaster (Dutch land use registry) [3]. On the level of 500x500 meter squares, it gives information about population density, age, income level, etc... Unfortunately, this data is not fully complete (due to privacy reasons, some information has been omitted in low-population areas and some squares are missing entirely from the dataset due to nobody living there) but you should be able to work around this.
Finally, information on the current locations of the 35 service points that currently exist in Maastricht is available. For the entire year of 2024, data has been collected on how many parcels have been (attempted to be) delivered to customers living in the neighborhood of that service point each day, as well as how many parcels were left (directly, without a delivery attempt) at the service point to be picked up by customers. A map with the locations of current service points, together with addresses color coded according to what service point they're served by, is reproduced in Figure 2:

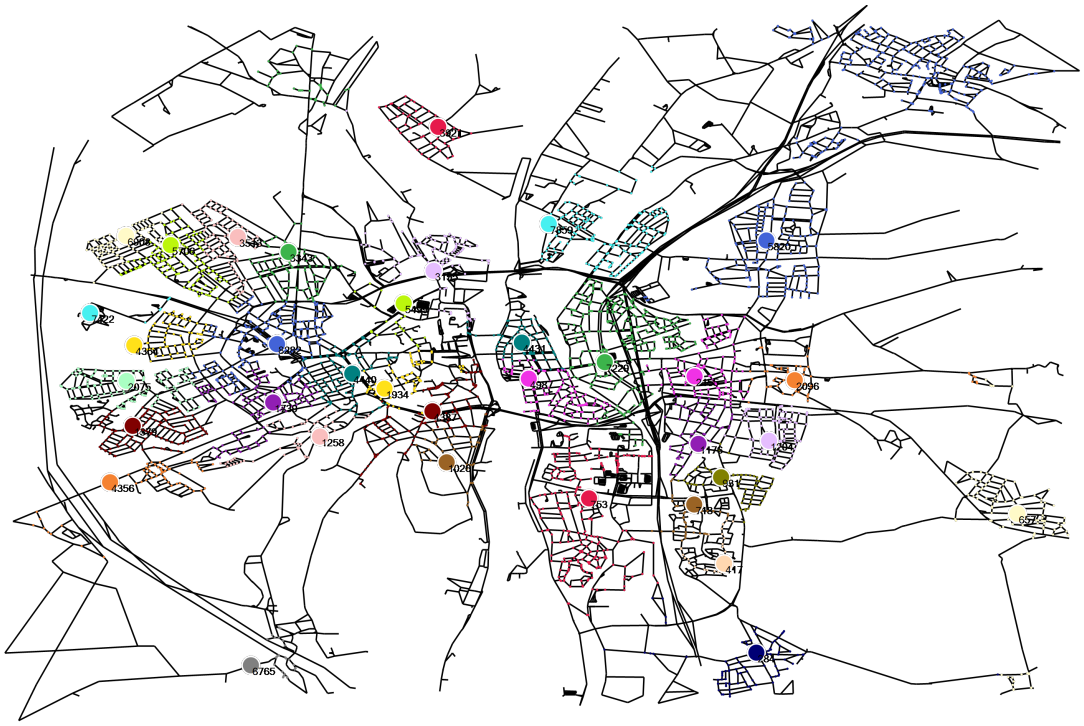

Figure 2: Current service point locations and the addresses they serve.

4 Milestone 2 (final): Choosing the service point locations and capacities

Having completed step 1, your next task is to come up with an initial proposal for the service point locations and capacities. There is a fixed cost yearly associated with running a service point of on average €50.000 (depending on the cost of real estate in the area), and also a cost related to the capacity of a service point: the capacity is the maximum number of parcels that can be collected from the service point by customers each day. The reason for this cost is that we must reserve space for storing the parcels and have to hire staff to hand out the packages to customers. It costs €0,10 per day to have capacity for handing out one parcel. It is not possible to change capacity on the fly: you have to commit to choosing a specific capacity when first setting up the service point.

On the other hand, if a customer elects to have their parcel delivered at home (which they may do particularly if the nearest service point is far away) a cost is incurred, which is related to the distance to the service point (because the truck driver collects the parcels to deliver from the service point and also has to drop them back off there is the customer is not home). Post&L does not have very accurate data on this cost. The accounting department currently estimates the cost of delivery in the following way, using a costing approach: to deliver a parcel to a customer has a cost of €1,50 per kilometer driving distance that the customer lives from the service point. It is suggested that you also use this estimation.

If, on a peak day, the service point does not have enough capacity to handle all parcels that are picked up there, the parcel will be delayed to an off-peak day. This is a major source of consumer dissatisfaction, but delays are sometimes unavoidable. Therefore, an important key performance indicator is the bounce rate: city-wide, it may happen it at most 1% of cases that there is not enough capacity for a parcel. Moreover, each service point should have less than 2% bounce rate.

During this project milestone, you will have to propose locations for the service points – and specify what capacities they should have – to minimize costs and guarantee that the KPI is met.

During this milestone, you should finalize your final report, answering the main questions, specifying the total costs and a breakdown thereof, and suggestions for how the delivery network should be organized going forward.

Finally, during this stage, you should also develop a second network proposal: one incorporating APLs, and report on whether these would be a worthwhile investment.

5 Optional: Optimizing the delivery routes

If you want to go the extra mile, you can consider optimizing the delivery routes. So far, we worked with an inaccurate estimation of the cost of delivering a package if the customer does not elect to pick it up. In reality, it costs €0,21 (in fuel and vehicle maintenance) for the delivery driver to drive a kilometer and drop off parcels along the way, with each parcel taking on average an extra 3 minutes to drop off (in addition to the driving time). Parcels are picked up from the service points at the beginning of the day and are delivered only to those addresses for which that service point is the closest. At the end of the shift, the driver returns to the service point. What a typical day looks like is variable depending on which addresses need packages delivered to, but it is important to have an estimate of what the average cost of an optimal route is. The maximum shift time of a driver due to labour regulations must be respected. They are allowed to work for at most 8 hours each shift. It is possible to hire drivers on a permanent contract, which costs €150 per (working) day. To handle peak demand, it is also possible to subcontract a driver from an independent company for a single day, but this costs €250 per day.
Does the information you gain lead to reconsidering the choices made during milestone 2?

References

[1] OpenStreetMap contributors. OpenStreetMap website, about page. `https://www.openstreetmap.org/about`.

[2] Oliver Lum. OARBench. `https://github.com/Olibear/OARBench`.

[3] Statistics Netherlands. Map, 500 meter times 500 meter squares, with statistics. `https://www.cbs.nl/nl-nl/dossier/nederland-regionaal/geografische-data/kaart-van-500-meter-bij-500-meter-met-statistieken`.

[4] PostNL. PostNL, 2020 Annual Report. `https://annualreport.postnl.nl/2020/`.

[5] PostNL. PostNL, 2024 Annual Report. `https://annualreport.postnl.nl/2024/`.