Optimisation Project Description - Van Delivery Scheduling for Woolworths NZ

Woolworths NZ operates the Woolworths and FreshChoice supermarket chains in New Zealand. Each store needs to receive goods daily to ensure their shelves are fully stocked. They operate a fleet of 4 large vans in order to move certain perishable goods from CentrePort in Wellington to their stores around Wellington.

On each day, each store receives boxes of perishable goods from CentrePort based on store sales. Therefore, the number of boxes shipped to each store differs each day. For this model, we will work in units of boxes, and we will not differentiate between different product categories.

Each van can carry up to 9 boxes of goods, and operates on a trip schedule that will have each van deliver goods to a selection of stores, and return to the warehouse. Once at the store, a box takes on average 15 minutes to unload due to necessary checks for product quality. Current policy requires each scheduled trip take no more than three hours, on average, to complete; this includes both driving time and unloading time. Each van costs $200 per hour to operate and can operate two (approximately) three-hour shifts per day. You may assume that the two shifts start at 8am or 1pm, and that each store only receives one delivery per day.

However, traffic conditions on Wellington roads are not always ideal, so the driving time required may well be longer or shorter depending on the time of day. This means some vans may take more than three hours to complete their trip. In such cases, the extra time costs Woolworths NZ $275 per hour.

On days where there are not sufficient vans to satisfy all demand, either because of a shortage of can time or an excess in store demand for boxes, additional vans can be ‘wet-leased’ (vehicle rental that includes a driver) from SUB60 for a cost of $1000 for every four hours of on-duty time, charged in four-hour blocks. A SUB60 van can only carry four boxes.

Woolworths NZ would like to determine a suitable long-term truck logistics plan such that costs are minimised - i.e. a plan that will work for most days that will not require live rescheduling daily. They have provided you with:

- the number of boxes delivered to each store they operate over a 4 week period: WoolworthsDemand2025.csv
- the GPS coordinates of each store: WoolworthsLocations.csv
- Map of all locations to assist you: Woolworths2025Map.png
- the travel durations (in seconds) between each pair of stores and distribution points: WoolworthsDurations2025.csv

Given the cost of operations, Woolworths NZ would like to outsource more of their logistics to SUB60 by reducing their own logistics fleet and allowing SUB60 to do more deliveries. Each Woolworths van incurs approximately $50,000 in maintenance and other costs per year.

Part I

1. Analyse the data provided to develop an appropriate estimate of the number of boxes required at each store on each day.
2. Using the pallet estimates, create a set of feasible trucking routes that satisfy the requirements given.
3. Formulate and solve a mixed-integer program to find the least-cost routing schedule for the truck fleet, using the demand estimates from part 1. This should also sensibly address the outsourcing proposal.

Part II

4. Create visualisation(s) of your proposed trucking routes, suitable for presentation to management.
5. Evaluate the quality of your schedule by creating a simulation to estimate the actual cost of satisfying all box demand at every store. Your simulation should take into variations in demand and sensibly approximate the effect of traffic. Simulation can also assist you in analysing the outsourcing proposal.
6. Discuss the impact of Woolworths' outsourcing proposal in terms of wider implications on the systems and people that interact with this truck logistics plan.
7. What are your recommendations to Woolworths NZ after conducting this study?

What we've already done:

We've completed all of Part I and Part II task 4. and it can all be seen in the ORProject2(1).ipynb file and our group model report for additional information on our selected routes for weekdays and saturday.

We're now onto the simulation in task 5.

Here's how we've divided the tasks for simulation:

- ☐ Demand Estimation
  - ☐ Distribution Fitting
  - ☐ Bootstrapping
- ☐ **Traffic Estimation**
  - ☐ **2 Shifts**
    - ☐ **8 am**
    - ☐ **1 pm**
  - ☐ **Obtain Traffic Data from TomTom API or Google traffic data**
  - ☐ **Form log normal distribution for each time on weekdays and saturdays**
- ☐ Simulation
  - ☐ Failsafe algorithm: What to do if demands exceed van capacity.
    - ☐ Sub60 on weekdays
    - ☐ Woolworths Van on Saturday?
    - ☐ 7 vans only $6893 ($56 more expensive)

Your task:
You ONLY need to do the **traffic estimation** section of this part. Try to complete the task in the ORProject2(1).ipynb file. Thanks!