Project: Hot Delivery Optimization for Last-Mile Logistics

Objective:
To develop a scalable optimization framework for a food delivery platform that improves operational efficiency, reduces delivery distances, and minimizes customer wait times. The project focused on progressively complex routing scenarios—from single-driver routing to multi-driver assignment under time constraints.

My Role and Contributions

1. Single Driver Routing – Foundational Model

I began by constructing a Mixed-Integer Linear Programming (MILP) model to generate the shortest possible delivery route for a single driver, using PuLP in Python. The model:

- Enforced that each pickup precedes its associated drop-off
- Eliminated subtours via MTZ constraints
- Minimized total travel distance

Result:
Created an optimal tour across all pickups and drop-offs with a minimal route length of 33.88 km, establishing a baseline for future scenarios.

2. Time-Constrained Routing

I extended the model by integrating food preparation times, driver travel speed, service time at each stop, and a 30-minute average wait time constraint for customers. Enhancements included:

- Time-indexed constraints to ensure timely pickups after food is ready
- Dynamic time propagation between stops
- A soft constraint on average customer wait time to prioritize service quality

Result:
Although total distance increased to 43.32 km, I reduced customer wait times to an average of 17.32 minutes, demonstrating the real-world value of time-aware dispatching.

3. Multi-Driver Routing with Order Assignment

I designed a full-scale optimization model for dispatching multiple drivers with:

- Custom starting locations and travel speeds
- Order-to-driver assignment logic
- Time, capacity, and distance constraints per driver

This model simultaneously determined:

- Optimal assignment of orders to drivers
- Individual driver routes minimizing distance and wait time
- Compliance with the platform's maximum wait time threshold

Result:

- Total distance: 49.71 km across 3 drivers
- Average customer wait time: 21.51 minutes, within the target
- Demonstrated a scalable approach to last-mile routing for real-world delivery platforms like Uber Eats or DoorDash

Tools & Skills Used

- Python (Pandas, NumPy, PuLP)
- Linear and Integer Programming (MILP)
- Time-constrained optimization
- Vehicle routing problem (VRP)
- Scenario analysis & performance trade-off modeling

Outcome

Minimizing distance alone proved unrealistic for delivery services. By including readiness and wait-time constraints, we reduced average wait to 17.32 minutes with slightly longer routes. Extending to multiple drivers improved scalability, keeping average wait at 21.51 minutes over 49.71 km. This shows that time-aware, adaptive routing better balances efficiency and service quality.