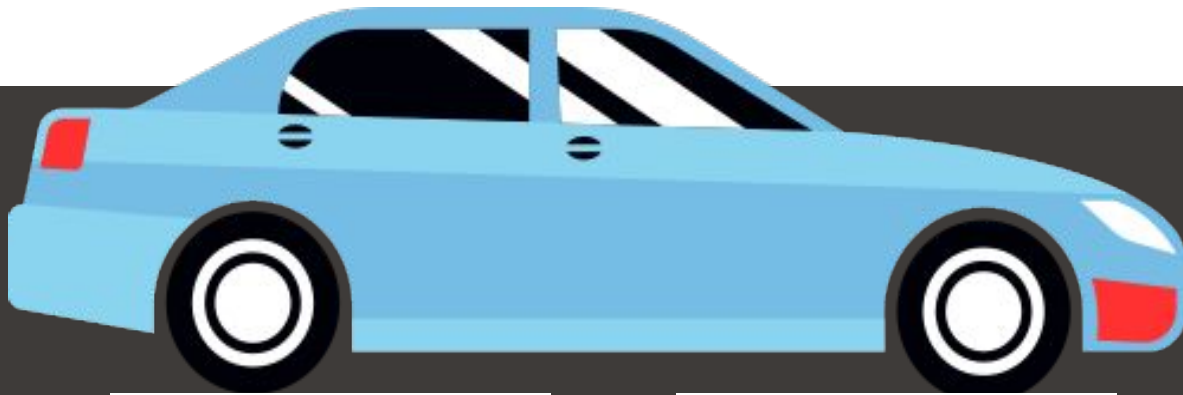


Via Proposal

Hybrid Night Shuttle Simulation

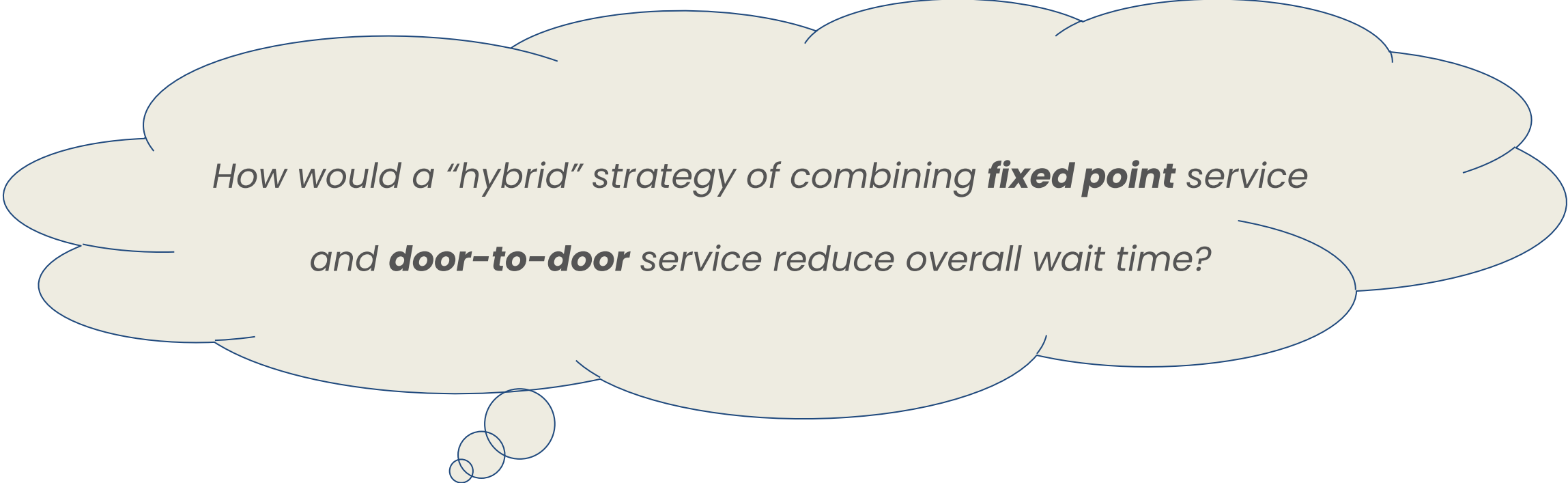
Evaluating Door-to-Door, Fixed Point-to-Fixed Point, and Hybrid Service Policies



Lucas, Muya, Sophia, Sabrina, Chung-Yeh

Problem Statement

- Current system: **door-to-door** (8 pm–3 am) service, **corner service** (before 8pm)
- Issue: With door-to-door, students experience longer wait times, especially during the peak hours of 9-11pm.
- Insight: Students experience shorter wait times with corner service.



How would a “hybrid” strategy of combining **fixed point** service and **door-to-door** service reduce overall wait time?

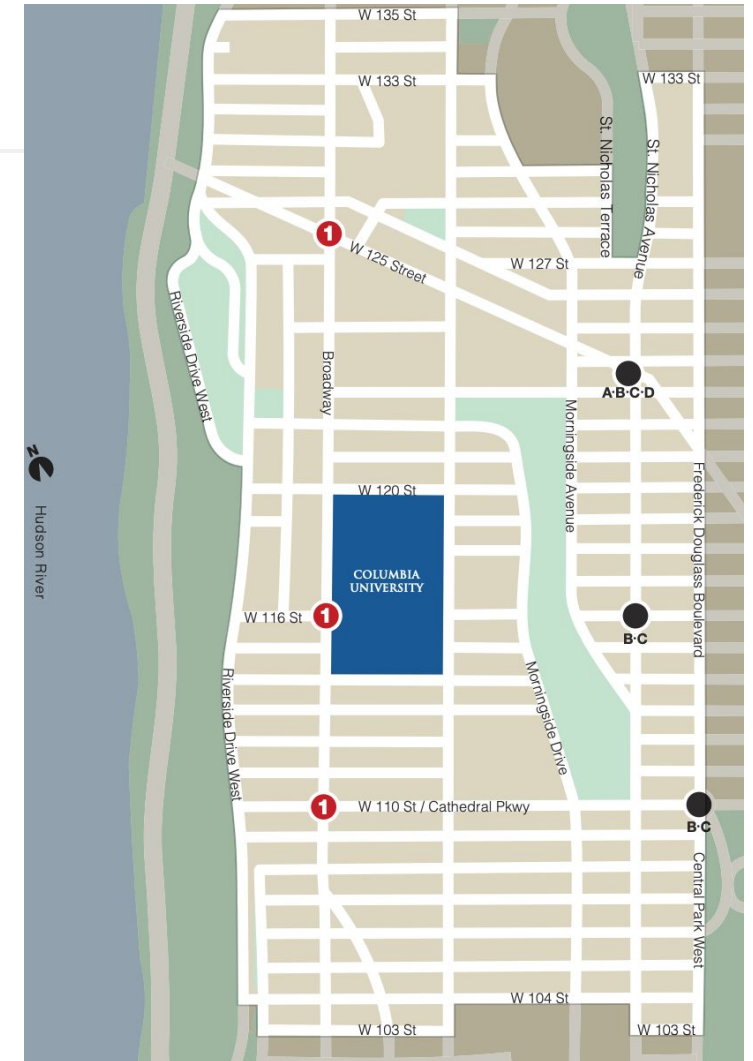
Assumptions

Simplified Street-Avenue Grid (for Fixed Points)

- **Longitude:** single value for each of the following avenues:
 - Riverside, Broadway, Amsterdam, Morningside, St. Nicholas.
- **Latitude:** latitude step approximation between streets
 - 103rd–135th (every 3 streets).

Distance & Travel Time Assumptions

- **Adjusted Haversine Distance:** Haversine distance, detour factor
 - (detour factor higher for door-to-door)
- **Driving speed:** ~ 8mph base (3.57 m/s) ; **Seat Capacity:** 3-6 seats
- **Walking speed:** 1.4 m/s (~3 mph)
- **Boarding time:** 90s per stop + 10s per extra passenger
- **Traffic variability:** probability of hitting a red light, hitting levels of congestions
- **250m** distance between blocks
- **Max waiting time:** 50 min; **Max riding time:** 30 min
- **Overflow drivers** (if needed)



Simulation Environment Setup

INPUT

- Geographical network
- Past supply data (**hourly vehicle availability**)
- Past demand data (**ride requests**)

SERVICE TYPE DECISION RULE (HYBRID LOGIC)

- Find **nearest corner** to origin & destination
 - If **both ends ≤ 3 minutes walk** → **fixed points**
 - If **either end > 3 minutes** → **Door-to-door**

UNIFIED DISPATCHER SYSTEM

- Account for **vehicle capacity**
- Enforces a **maximum wait-time**
- Prioritizes vehicles with **shorter queues**
- Gives a **small priority to corner trips**

REQUEST SYSTEM SIMULATION

- Dynamic routing based on **real-time availability**
- Process requests **in the order they arrive**
- Advanced simulation clock **to each request timestamp**

Agent Logic: Vehicle Processing

State: location, onboard passengers, dynamic route

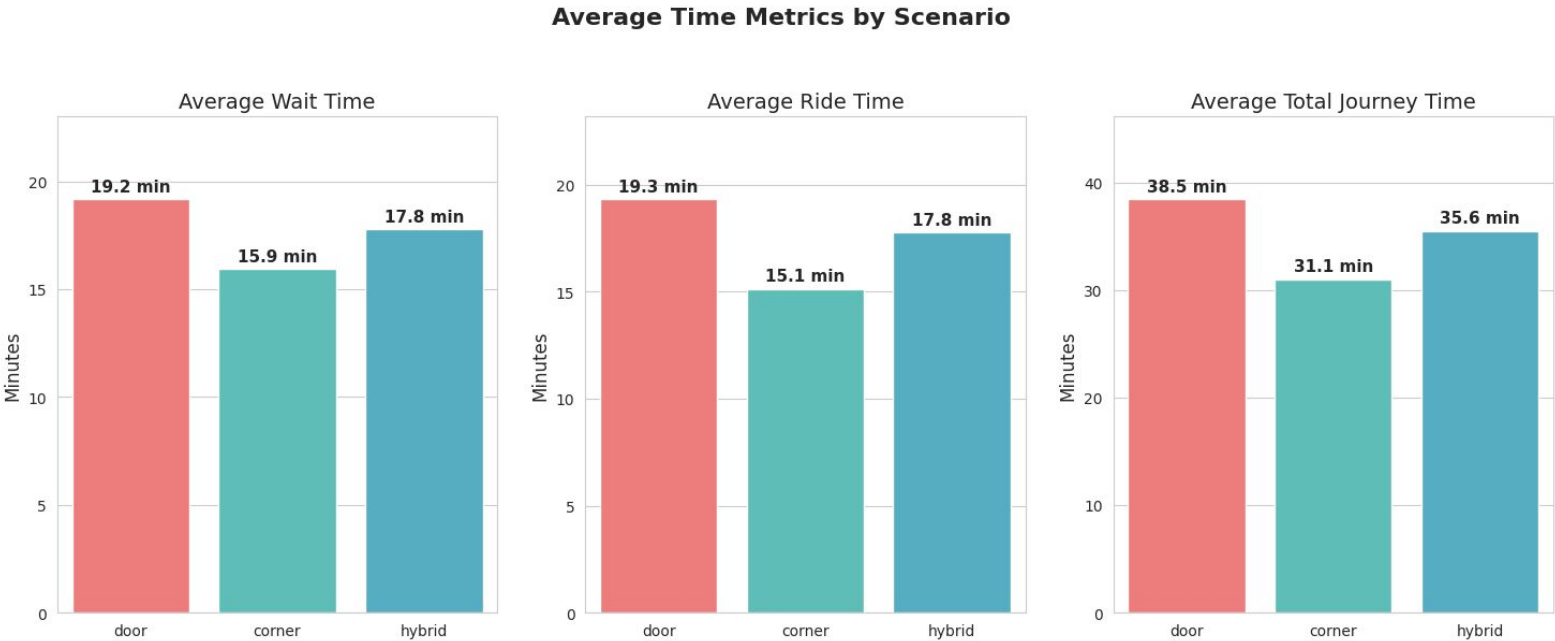
When serving a “stop” on the route:

- Batch all pickups and dropoffs at that location
- Compute travel time:
 - Fixed points → faster, more direct
 - Door-level → side-street detours
 - take traffic lights + congestion
- Apply fixed delay before moving
- Apply dwell time based on number of boardings

- **Update passenger states:**

- Log pickup time + actual wait
- Log drop off time + ride duration
- Continue until route is empty

Overall Results: Average Performance

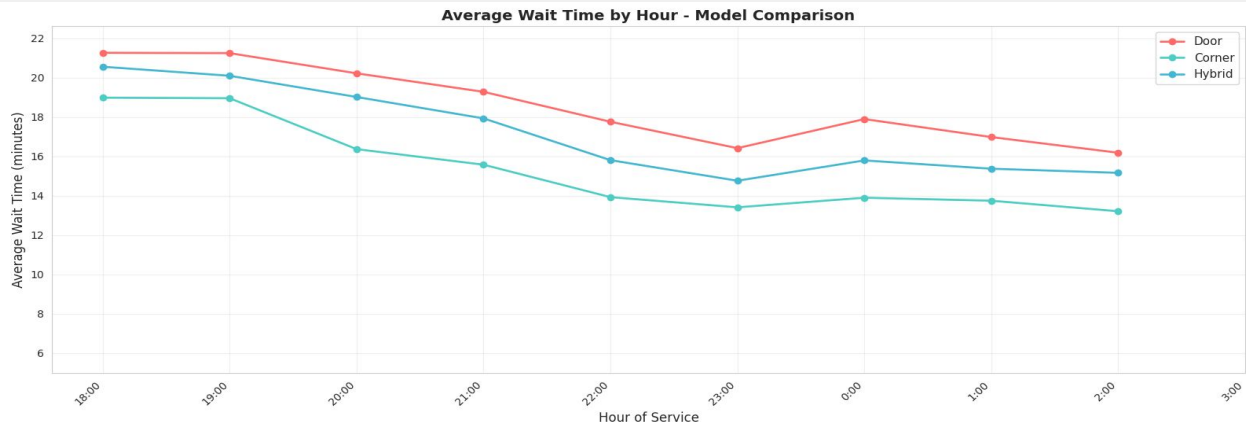


Scenario Performance Summary

Scenario	Avg Wait (min)	Avg Ride (min)
Door	19.2	19.3
Corner	15.9	15.1
Hybrid	17.8	17.8

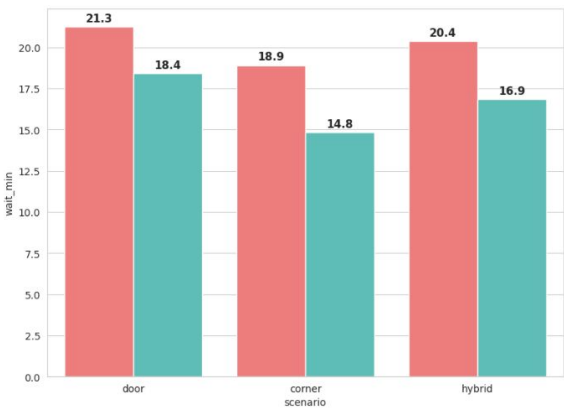
- Corner has the lowest averages
- Door has a more long waits and rides
- Hybrid Improving total speed by roughly 10% over Door-to-Door while retaining some convenience.

Patterns by Group (Average Wait)

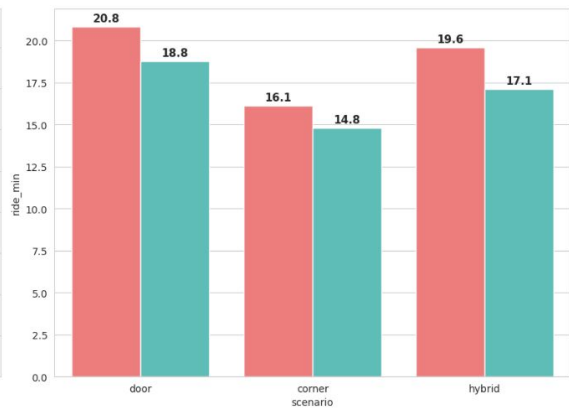


Trend by Hour

Average Wait Time

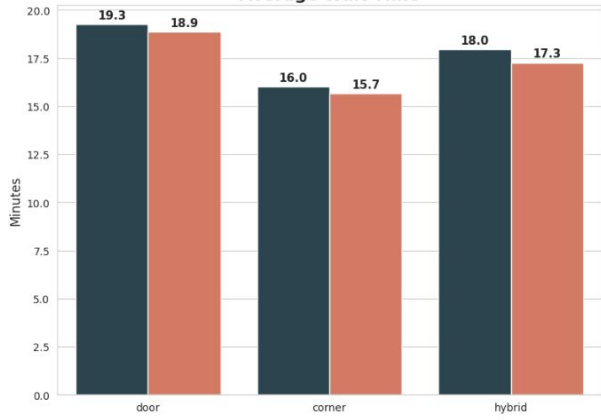


Average Ride Time

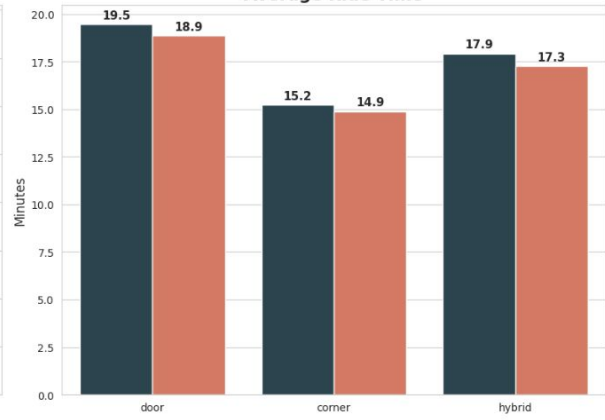


Before 8 v.s. After 8

Average Wait Time

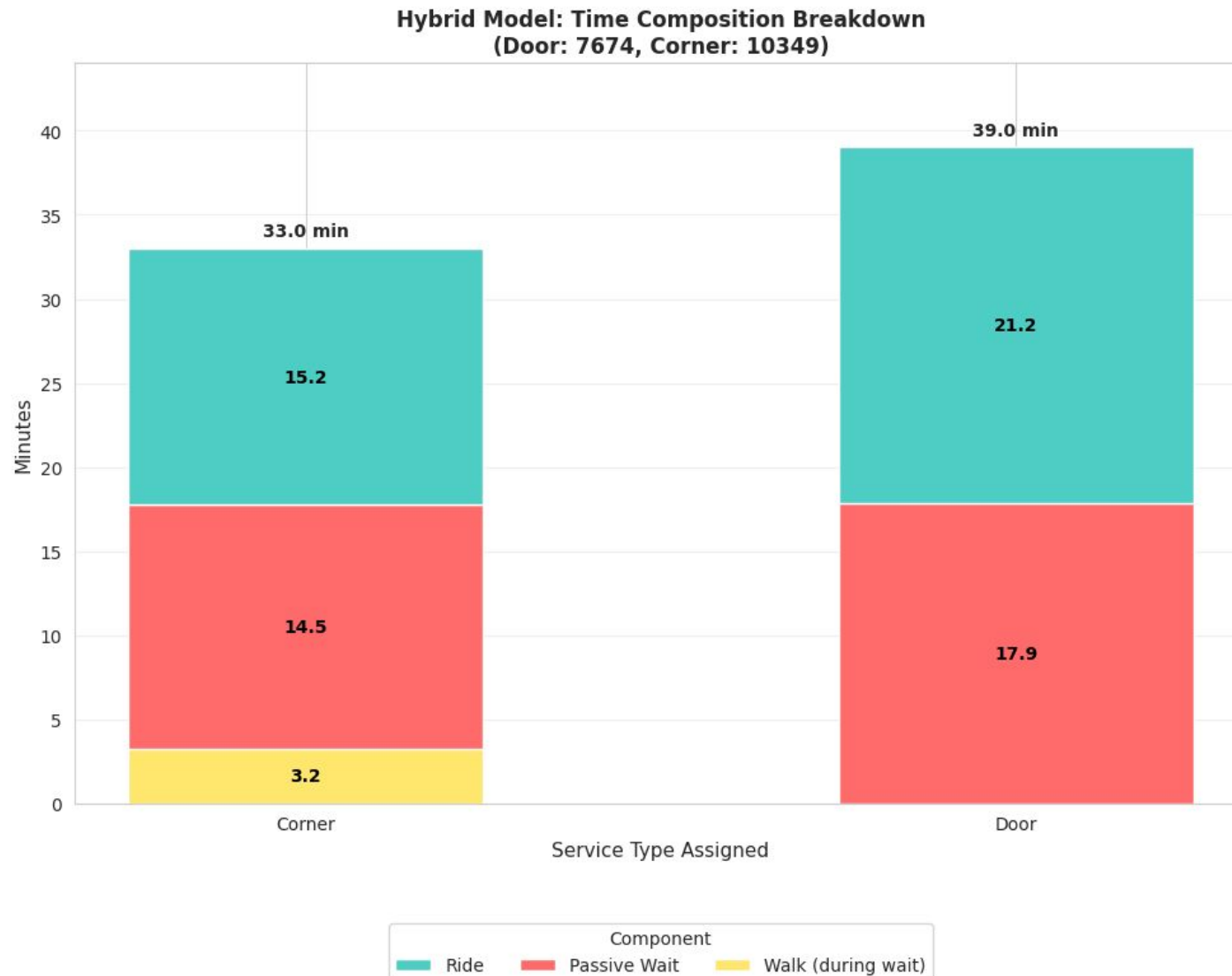


Average Ride Time



Weekday v.s. Weekend

Hybrid User Breakdown (58% Corner Qualified)



Users Benefit

- About 57.4% of riders qualify for corner service and enjoy shorter waits and total time
- Remaining 42.6% keep full door-to-door access
- Hybrid rule improves efficiency without sacrificing accessibility.

Sensitivity Analysis: does n_fixed point matter?

current corner -> 55 (Every 3 street)

new_corner -> 85 (Every 2 street)

Metric	Current(Avg)	New(Avg)
Wait Time(Door)	19.2 min	19.4 min
Wait Time(Corner)	15.9 min	16.0 min
Wait Time(Hybrid)	17.8 min	18.0 min
Ride Time(Door)	19.3 min	19.7 min
Ride Time(Corner)	15.1 min	15.3 min
Ride Time(Hybrid)	17.8 min	17.9 min

	Current	New
Door Users	42.6%	41.6%
Corner Users	57.4%	58.4%

Policy Insights & Future Work

Policy Insights

- **Corner-to-Corner-Only:** Most operationally efficient but inconvenient for riders
- **Door-to-Door-Only:** Most convenient for riders but operationally inefficient
 - (leads to highest waits and VMT (Vehicle Miles Traveled))
- **Hybrid:** Provides a practical compromise between the two policies to improve waiting time post-8pm

Limitations & Future Work

- **Limitations:**
 - Single month analysis
 - Simplified travel and dwell models
 - (inefficiencies in real world)
- **Future Work:**
 - Sensitivity analysis on the 3-minute walk threshold and cost weights.
 - Implementing user opt-in to corner service for further demand management.
 - Determining best fixed points