Final Project: Smart City Data Hackathon

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How weather impacts New-York taxi service?

What We Analyzed

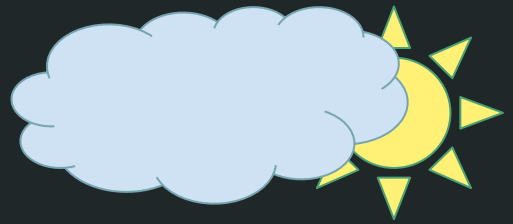
- Over 21 million taxi trips from December 2024
- Combined with detailed hourly weather data

- Why December?

The perfect natural experiment Mix of clear days, rain, and snow also it is a peak demand period with holiday shopping and travel

PS:If the system struggles in December, problems exist year-round

Bad Weather Slows Everything Down

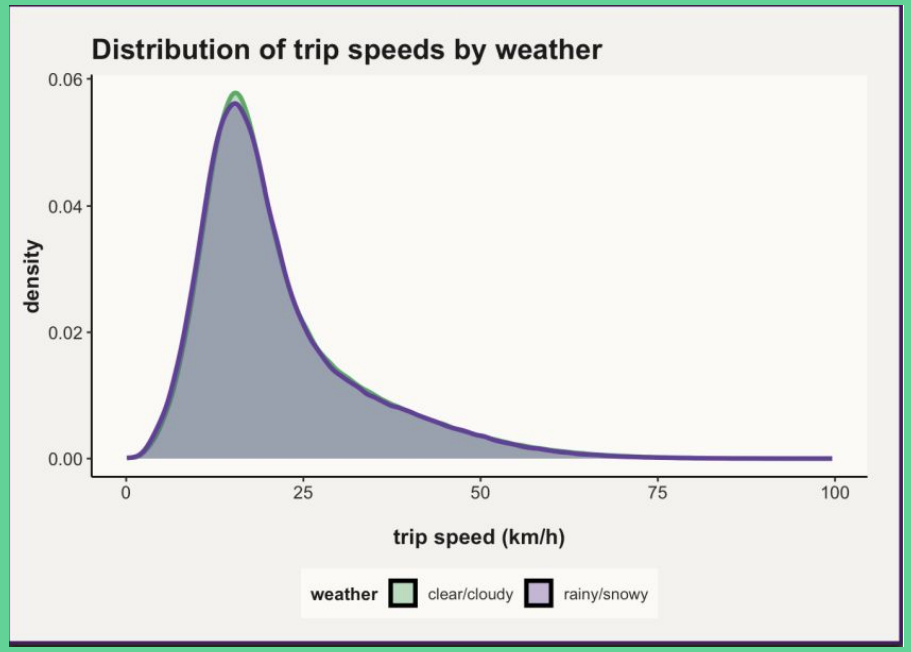


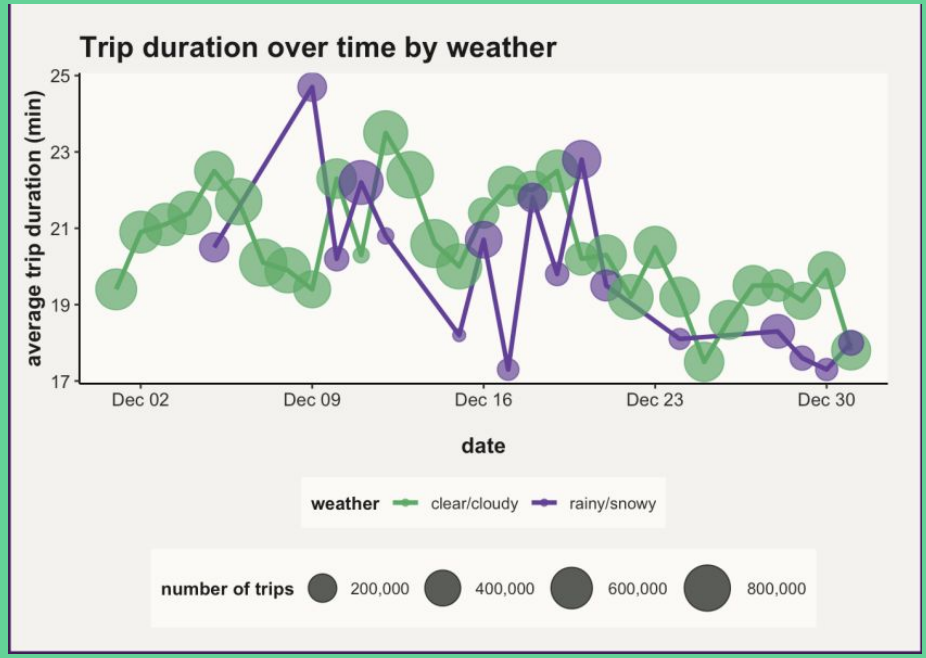
When it rains or snows:

- Speed drops by 1.4% (from 21.6 to 21.3 km/h)
- Wait times jump from 4.0 to 4.4 minutes — a 10% increase
- This affected 3.6 million trips in December alone

Impact of precipitation on trip metrics

condition	trips	average duration (min)	average speed (km/h)	average distance (km)	average wait (min)	average fare ($)	duration change (%)	speed change (%)
Bad weather (rain or snow)	3624684	20.7	21.3	8.18	4.4	31.71	0.5	-1.4
Great weather (clear or cloudy)	17328011	20.6	21.6	8.23	4.0	30.09	0.0	0.0
NA	112837	16.9	20.9	6.65	6.1	28.10	-18.0	-3.2


Distribution of trip speeds by weather
density
0.06
0.04
0.02
0.00
0
25
50
75
100
trip speed (km/h)
weather
clear/cloudy
rainy/snowy


Trip duration over time by weather
average trip duration (min)
25
23
21
19
17
Dec 02
Dec 09
Dec 16
Dec 23
Dec 30
date
weather
clear/cloudy
rainy/snowy
number of trips
200,000
400,000
600,000
800,000

Geographic Inequality

Trip volume and wait times by borough:

- Manhattan: 8 million trips, 3.9 min average wait
- Brooklyn: 5.6 million trips, 4.0 min wait
- Queens: 4.5 million trips, 4.2 min wait
- Bronx: 2.7 million trips, 4.2 min wait
- Staten Island: Only 325k trips, 5.5 min wait

Trip statistics by pickup district

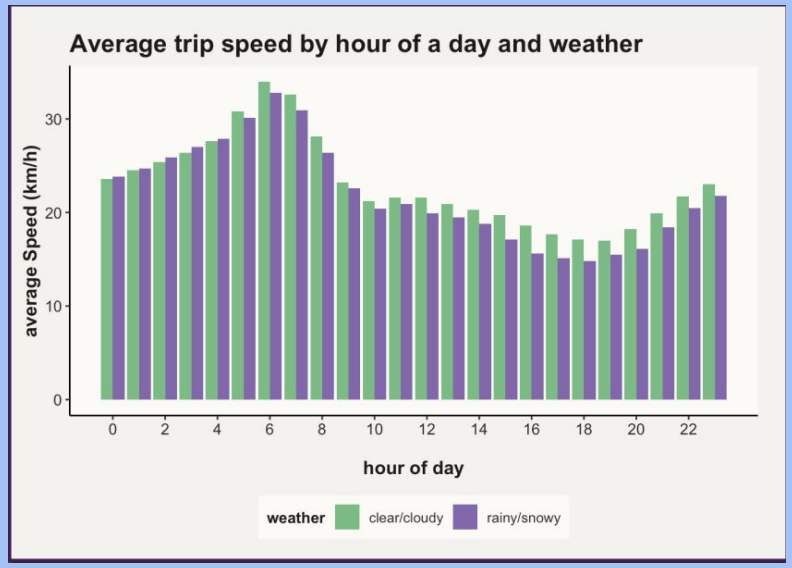
district	trips	average duration (min)	average speed (km/h)	average distance (km)	average wait (min)
Manhattan	7979512	22.4	20.2	8.53	3.9
Brooklyn	5569301	19.1	19.4	6.82	4.0
Queens	4531395	21.8	25.1	10.04	4.2
Bronx	2659171	16.6	23.2	7.01	4.2
Staten Island	325398	16.7	28.0	8.72	5.5
N/A	754	19.3	29.3	10.59	7.3
EWR	1	65.0	3.2	3.46	4.6

Rush Hour Patterns

Time of day matters:

- **5-7 AM**: fastest speeds (30+ km/h), because roads are empty
- **7-9 AM**: morning rush, speeds drop to 19 km/h
- **4-8 PM**: evening rush is worse, so speeds hit 16.7 km/h at 7 PM
- **Late night (12AM-4 AM)**: decent speeds but wait times spike due to fewer drivers

These patterns repeat every single day.



Combined Effects

Weather hits different neighborhoods differently

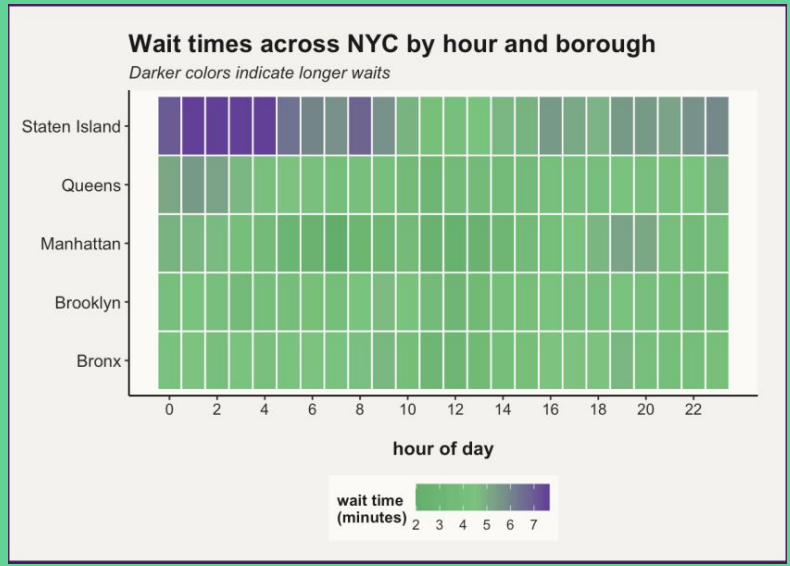
Manhattan during rain:

- Wait times increase from 3.8 to 4.5 minutes (+18%)
- Still better than most outer boroughs on clear days

Queens during rain:

- Wait times: 4.2 to 4.5 minutes
- Speed drops from 25.2 to 24.8 km/h

The pattern: Manhattan handles bad weather better because there are more cars available. Outer boroughs suffer more with fewer cars.



Proposed Solutions

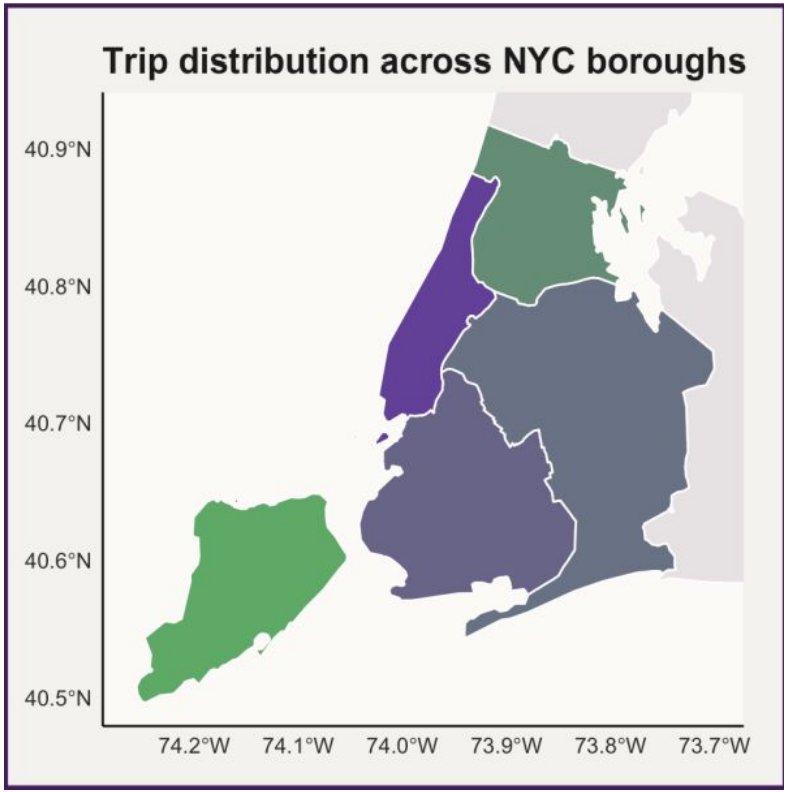
What can be done?

- ★ **Use weather data to preposition cars**
  - Send alerts to drivers when rain/snow is forecasted
  - Offer bonus pay ($2-3 per trip) for positioning in high-demand areas
  - Trigger emergency protocols during extreme weather
- ★ **Smart rush hour management**
  - Pre-position vehicles 30 minutes before known rush periods
  - Use ML models to predict demand by neighborhood and hour
  - Coordinate with NYC DOT for traffic light timing

Conclusions

We analyzed **21 million taxi trips** and found:

- ★ Bad weather slows everything — speeds drop 1.4%, wait times jump 10%
- ★ Geography matters — Manhattan gets 24x more trips than Staten Island
- ★ It's all predictable — rush hour and weather patterns repeat daily

Impact: Saving just 1 minute per trip equals 350,000 hours returned to New Yorkers monthly.

Small improvements multiply across millions of trips, benefiting passengers, drivers, and the environment.