How Would For-Hire Autonomous Vehicles Impact New York City?

Lessons from California on Safety, VMT, and Parking

Sam Schwartz Transportation Research Program at Roosevelt House
HUNTER The City University of New York
OpenPlans

ACKNOWLEDGEMENTS

We would like to thank our reviewers for their time and input (in alphabetical order): Erich Arcement, Nicole Gelinas, Adrian Pietrzak, Deena Schwartz, and Gerard Soffian. We would also like to thank the New York City Department of Transportation and Taxi and Limousine Commission for their generosity in providing us with the essential data needed to conduct our analyses.

PUBLICATION TEAM

Kelly McGuinness
Report Lead
Director
Sam Schwartz Transportation Research Program
The Roosevelt House Public Policy Institute at Hunter College

Michael Sutherland
Report Lead
Senior Policy & Legislative Analyst
Open Plans

Talya Schwartz
Senior Strategist
Open Plans

Sara Lind
Co-Executive Director
Open Plans

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EXECUTIVE SUMMARY

Autonomous for-hire vehicles, better known as robotaxis, are operational in cities across the globe. In New York City, Waymo (one of the leading robotaxi companies and a subsidiary of Alphabet, Inc., the parent company of Google) received a permit to test their vehicles with a safety driver, which expired in March 2026. Robotaxi companies have spent millions of dollars in New York City and State lobbying for the legalization of robotaxis.

However, a core question remains unanswered: how might robotaxis impact our streetscape in comparison to the professional for-hire vehicle drivers of taxis, Ubers, and Lyfts? In this report, we explore this question through the lenses of safety, vehicle miles traveled, and parking. Waymo has the most prolific robotaxi fleet in the United States, and required public reporting in California gives us a unique look into their operations, which is why we choose to analyze Waymo data in this report. We compare the best currently available public data from Waymo's fleet operations in California, their self-published national safety data, and novel data on New York City's for-hire fleet from the city's Department of Transportation and Taxi and Limousine Commission and come to important conclusions.

1. **Initial data shows that Waymo vehicles are involved in fewer injury-causing crashes overall, but have a significantly higher rate of crashes with a serious injury or fatality than the existing New York City for-hire fleet.** Nationally, Waymo vehicles have been involved in approximately 67% fewer injury-causing crashes (ranging from minor injuries to fatalities) per million miles driven — roughly one-third the rate of the city's for-hire vehicles. However, when isolating crashes with a death or serious injury, the trend reverses sharply; Waymo's national death or serious injury crash rate per million miles is one and a half times that of New York City's for-hire fleet, and in the San Francisco Bay Area, is more than three times the city's for-hire fleet.
   a. Waymo compares their safety data to the average human driver, but **New York City for-hire vehicles are in serious or fatal crashes at a rate 14-times less than the average New York City vehicle.** Comparing robotaxis to the for-hire fleet they would most likely replace is a better comparison.
   b. **Waymo's fleet has not yet driven enough miles to support that they are safer than for-hire vehicle drivers.** These initial severe crash

metrics warrant significant caution and further scrutiny. This is especially relevant as robotaxi companies continue to push forward for full authorization in cities and states across the country, including New York.

2. **As it stands, replacing a high-volume for-hire vehicle in New York City with a robotaxi would increase vehicle miles traveled and congestion.** Waymo vehicles deadhead — drive empty, with no passenger in the car — more than New York City's high-volume for-hire vehicles (e.g., Uber and Lyft). For every mile with a passenger, a Waymo vehicle in California logs 14.8% more empty driving miles than a New York City Uber or Lyft.
3. **New York City's constrained parking supply would likely dramatically increase Waymo's deadheading if deployed in the city, leading to more traffic and wear on the streets.** We estimate that Waymo vehicles spend over half their waiting time parked in California. Our analysis finds that every 1% decrease in parked time would result in a 1.5% increase in deadheading; for example, if Waymo vehicles were only able to park 33% of the time while waiting for a ride in California, their deadheading would increase by 37%.

With a grasp on these issues, we provide New York City (and other cities facing the issue of robotaxi legalization) with ways to prepare a more effective regulatory environment, including:

- Require robotaxi companies to compare their safety data to professional, for-hire vehicle drivers as a prerequisite to licensure to operate
- Require data transparency from robotaxi companies in order to conduct critical analyses
- Prepare fees to adequately capture and reduce the impact of robotaxis on our streets
- Stop centering single-use vehicles and consider how automated public transit can fill holes in our transit system
- Consider limiting robotaxis' ability to travel within dense, transit-rich commercial areas
- Expand for-hire vehicle pick-up/drop-off zones
- Manage licensing and control deployment to prevent excessive robotaxi vehicle miles traveled growth

With this initial research, we hope to spur discussion about the potential impacts of robotaxis — safety, vehicle miles traveled, parking, and others not discussed in this paper like labor and privacy — to make our streets work for all users.

Waymo vehicles have lower injury-causing crash rate overall, but higher severe crash rate

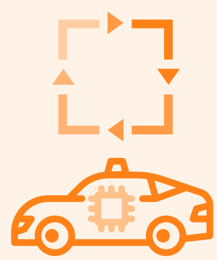
67% fewer **injury-causing crashes** than NYC's for-hire fleet

1.5x

the **death/serious-injury crash rate** of NYC for-hire fleet, nationally — more than 3x in the San Francisco Bay Area

Based on crash rates per million miles driven

Robotaxis drive more empty miles per trip



+14.8%

more empty (deadheading) miles per passenger mile than NYC's Uber and Lyft fleet

Based on Waymo's California fleet operations data

Less parking means more empty driving

Waymo vehicles **spend over half their waiting time parked** in California

+37%

more deadheading

if parking availability fell to 33% — NYC's constrained supply makes this a real risk

Every 1% drop in parked time raises deadheading by 1.5%

Introduction

In the past decade, we have seen a significant proliferation of autonomous vehicle (AV) technology. Personal vehicles with semi-autonomous features have entered the market, and there has been heavy investment in technology for autonomous for-hire vehicles, also known as robotaxis. Robotaxis are operational in dozens of cities around the globe in a testing or commercial capacity, and they have been tested with a human safety operator on New York City streets.[1] The most prominent robotaxi companies include Waymo (owned by Google's parent company Alphabet, Inc.), Zoox (owned by Amazon), and Tesla; Uber is making initial moves to shift some operations to robotaxis.[2]

Waymo is a leader in early expansion efforts. While they're most prominent in the Bay Area of California in cities like San Francisco, they're fully operational in ten other cities, including Phoenix, Austin, and Miami. Substantial expansion efforts are ongoing, and as of June 2026, 21 cities are listed as "up next" on Waymo's website, including New York, London and Tokyo.[3] Waymo is the only company that has operated a pilot program in New York City (with a safety operator behind the wheel at all times, as fully driverless vehicles are not legal in New York State).

> ***There are a number of unanswered questions about how robotaxis would impact dense cities like New York City.***

There are a number of unanswered questions about how robotaxis would impact dense cities like New York City. Would they contribute to a safer street ecosystem? How would they impact vehicle miles traveled (VMT), an important metric to measure road use on city streets? What would be their effect on congestion, and how would they interact with the curb and parking management? What impact would they have on our streetscape?

A substantial portion of robotaxis' purported value is perceived safety benefits. Waymo claims that their vehicles cause 94% fewer crashes resulting in serious injuries or worse.[4] Experts have asserted that Waymo has not driven enough miles in all conditions, and that billions of miles would need to be driven to make definitive safety conclusions; as of June 2026, Waymo has driven roughly 220.6 million miles.[5] Waymo's comparisons are between Waymo vehicles and all drivers, and not solely between them and the

professional, for-hire drivers they would be replacing or supplementing who historically perform better than everyday drivers.[6] Additionally, multiple recalls and issues — cases where Waymo vehicles passed stopped school buses, drove through freeway work zones, and waded through a flooded road — raise questions about the potential for future issues.[7] These observations are not to say that Waymo's claims of safety are categorically untrue or without merit, but instead require intense scrutiny. Further, publicly available VMT data provided by Waymo (including data points like trips and waiting time) is geographically generalized and not granular enough to draw more specific conclusions. Driving patterns are different in rural, suburban, and urban areas, and localized VMT data allows researchers to make apples-to-apples comparisons (described further in the **Data Considerations** section).

The fact that robotaxis are autonomous results in new challenges to reducing VMT: the vehicles are not constrained by the limits of a human driver, just their battery, and therefore can circle for extended periods of time, be in service for longer hours, and take longer routes. VMT is an essential metric to understand the presence and impact of vehicles. It is a measure of how many miles are driven by vehicles in a given area, and it's important to monitor in the effort to reduce congestion and make public transit more efficient.[8] A recent independent meta-analysis found that robotaxis could increase VMT in a given city by 5.3%.[9] These impacts are compounded if there is no curb access; an analysis (funded in part by Waymo) found that if robotaxis did not have access to the curb for pick-up, drop-off, and downtime, the VMT of the study's theoretical fleet of 1,800 vehicles would increase by 60%.[10]

Most current research into the potential impacts of robotaxis employs theoretical robotaxi fleet models. But now that we have operational data from Waymo's fleet in California, and safety data from their deployments nationwide, we can investigate how that fleet actually performs and estimate how robotaxis may impact New York City. In this report, we attempt to investigate questions about safety, VMT impact, and curb management by asking: how would robotaxis fit into our larger transportation ecosystem? To do so, we compare key data from Waymo vehicles, both in California and nationally, and for-hire vehicles in New York City. With this research, we hope to contribute to the ongoing conversation around autonomous vehicles, robotaxis, and their impact on our city's streets.

Data

For our analyses, we use VMT and crash data from the NYC Department of Transportation (DOT) and the NYC Taxi and Limousine Commission (TLC), obtained both through the NYC Open Data portal and provided directly to our research team. Waymo did not respond to our multiple requests for additional data.[11] We also use publicly accessible VMT and crash data provided by Waymo via its website, as well as data from the California Public Utilities Commission (CPUC). More details on the data used can be found in **Appendix A1**.

Safety Analysis

When making safety claims, Waymo benchmarks its driverless vehicle safety record against the average human driver. The company asserts that Waymo vehicles get into 94% fewer crashes resulting in a serious injury or death, and 82% fewer crashes causing any injuries as compared to human drivers.[12] But robotaxis won't replace the average driver, they'll replace professional, for-hire drivers who historically have better safety records than the general public in New York City and beyond.[13] **The best comparison isn't robotaxis versus everyone, it's robotaxis versus the for-hire fleet they would replace.**

Our analysis compares the safety records of New York City's for-hire vehicles (FHVs) — yellow taxis and high-volume for-hire vehicles (HV-FHV, e.g., Lyft and Uber) — against Waymo's autonomous fleet using incidents per million miles. It looks at two types of crash outcome severities:

- **Injury-Causing Crash**: a crash with at least one injury reported, including minor, moderate, and serious injuries, as well as deaths.
- **Serious-Injury or Worse Crash (known as killed or seriously injured, or KSI):** a crash with at least one critical injury or fatality. KSI crashes are a subset of injury-causing crashes.

KEY FINDINGS:

1. Our KSI analysis shows that **Waymo vehicles have been involved in more KSI crashes per million miles traveled than FHVs in New York City**. Waymo's nationwide KSI crash rate is 1.5-times New York City's FHV rate, and Waymo's San Francisco Bay Area crash rate is more than 3-times greater. In other words, New York City FHVs are involved in 33% and 69% fewer KSI crashes per million miles than Waymo nationwide and in the Bay Area, respectively.
2. Our Injury-Causing Crash analysis shows that **Waymo vehicles have been involved in about 67% fewer injury-causing crashes per million miles**, or roughly one-third the rate of the city's FHVs.
3. Waymo compares their safety data to the average human driver, but **New York City FHVs are in KSI crashes at a rate 14-times less than the average New York City vehicle**, which makes them a better comparison.
4. **Waymo's fleet has not yet driven enough miles to support that they are safer than FHV drivers.** These initial severe crash metrics warrant significant caution and further scrutiny. This is especially relevant as robotaxi companies continue to push forward for full authorization in cities and states across the country including New York.

Determining Crash Rates

Each rate is calculated as crash incidents divided by VMT, scaled to one million miles. We use the rate "per million miles" (PMM) since raw crash counts cannot be compared across fleets of different sizes. A fleet that drives ten times as many miles will (all else equal) have roughly ten times as many crashes — not because it is more dangerous, but because it is on the road more. Taxis and HV-FHVs drove almost eight times more in just 2025 than all of Waymo's driverless miles between its launch in 2020 to March 2026. Normalizing by distance traveled produces a rate that reflects risk per exposure, therefore we chose to normalize by per million miles traveled.

A 95% confidence interval indicates the range within which the true crash rate is likely to fall, given the observed data, with 95% certainty. 95% confidence intervals for crash rates are calculated using the exact Poisson (Garwood) method, which is standard for rare-event rate estimation and does not require large samples.[14] Intervals are computed based on observed crash counts and VMT for each vehicle category, then expressed as crashes per million miles.

The data for New York City FHV and Waymo crash data span different years: 2025 for New York City figures and for Waymo cumulatively since its system launch to the public in September 2020 through March 2026. This difference in time periods does not undermine the validity of the per-mile rates themselves, since each rate is normalized by that category's own exposure (miles driven). It does assume that risk per mile is reasonably stable over time.[15] This difference in time periods mirrors what Waymo produces for their safety benchmarks, which examines their driverless vehicle performance since launch compared to one full year of all drivers.[16] Waymo has scaled its operations significantly in recent months and years, and therefore much of their mileage is skewed to recent times.

Further details on our methodology and data sources for this section can be found in the **Appendix (A1)**.

The Importance of Human FHV Benchmarks

Waymo compares its safety data to all drivers rather than to human FHV drivers specifically. Our analysis shows the flaws in that approach. Citywide, the gap between all drivers and FHV drivers is significant; New York City FHVs are in 14-times fewer KSI crashes than the average vehicle (**Table 1**). Comparing Waymo only to all drivers citywide, Waymo performs 9-times better on KSI crashes, but that comparison uses the wrong benchmark, since FHVs already outperform the average driver by a wider margin. The best comparison isn't robotaxis versus all drivers: its robotaxis versus the for-hire fleet they would replace.

Table 1: Killed or Seriously Injured (KSI) Crash Rates

Killed or Seriously Injured (KSI) Crash Rates

Vehicle Type	Vehicle Miles Traveled	KSI Crashes	KSI Crashes Per Million Miles	95% Confidence Intervals
All Vehicles (New York City)	**24,462,691,033**	**3,188**	**0.130**	**0.126 – 0.135**
New York City For-Hire Vehicles (Combined)	**1,750,149,509**	**16**	**0.009**	**0.005 – 0.015**
Yellow Taxis	317,877,185	4	0.013	0.003 – 0.032
High-Volume For-Hire Vehicles	1,432,272,323	12	0.008	0.004 – 0.015
Waymo (All Deployed Locations, Nationally)	**220,613,000**	**3**	**0.014**	**0.003 – 0.040**
Waymo (San Francisco Bay Area)	67,078,000	2	0.030	0.004 – 0.108

Sources: *NYC Taxi & Limousine Commission crash data (2025); NYC Department of Transportation VMT data (2025); Mayor's Office of Climate and Environmental Justice VMT data (2024); New York Police Department crash data (2024); Waymo crash and VMT data September 2020 through March 2026 (see* ***Appendix A1*** *for further data and methodology details).*

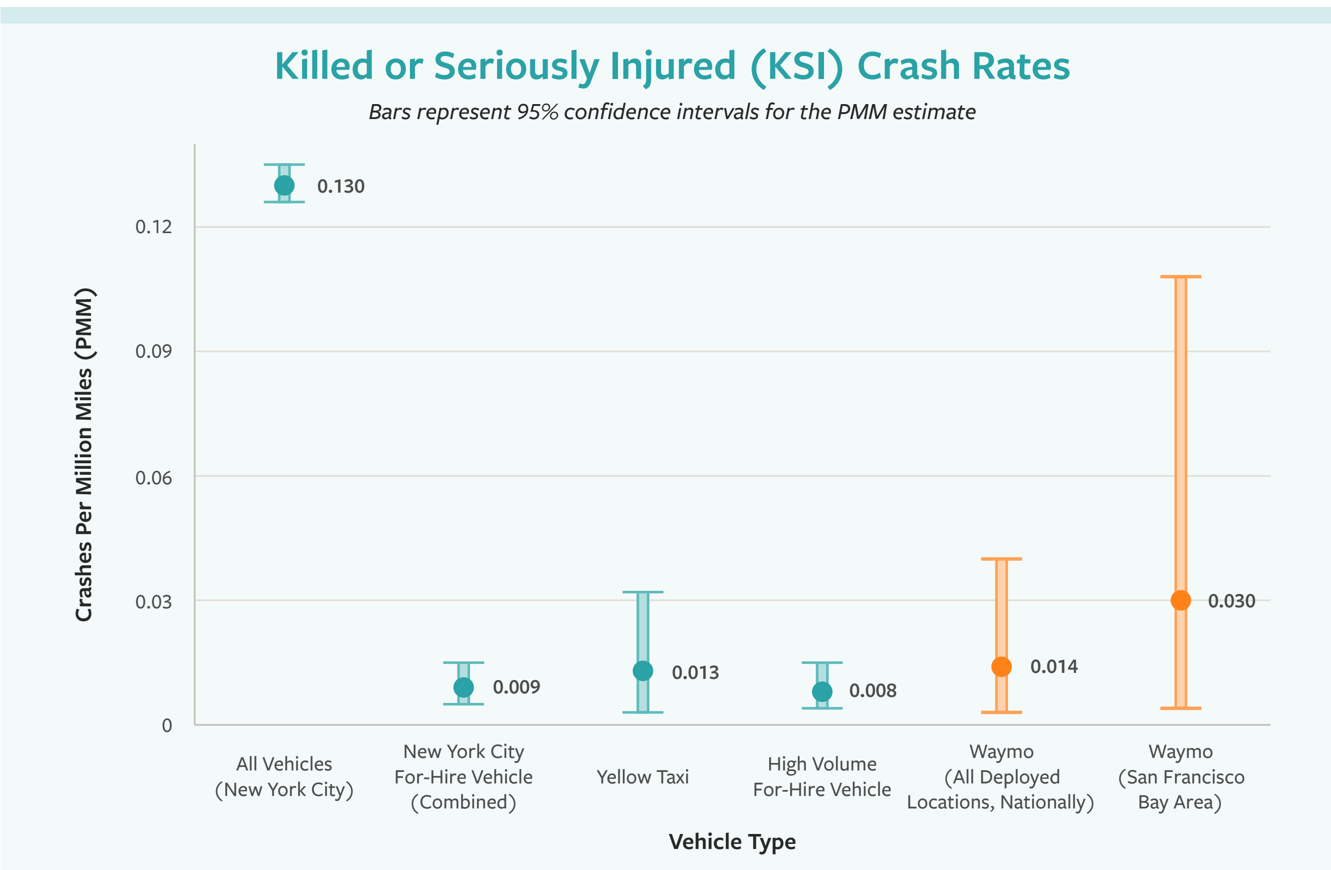
Killed or Seriously Injured (KSI) Crashes

Table 1 shows that for crashes with deaths or serious injuries — the most crucial Vision Zero data point — Waymo reports 0.014 KSI crashes PMM across all deployed locations nationally, and 0.030 KSI crashes for the Bay Area (which is more comparable to New York City in terms of streetscape). Our analysis found that New York City FHVs had 0.009 KSI crashes per million miles in 2025. The data available so far point in a concerning direction: Waymo's nationwide KSI crash rate is 1.5-times the city's FHV rate, and their San Francisco Bay Area crash rate is more than 3-times that of the city's for-hire fleet.

When comparing Waymo vehicles to the existing FHV fleet, we find that Waymo's fleet has not yet driven enough miles to support that they are safer than FHV drivers. **Figure 1** illustrates the 95% confidence intervals underlying these estimates. New York City's FHVs have a tight interval of 0.005 to 0.015, reflecting 16 crashes over 1.75 billion miles. Waymo's intervals are far wider: 0.003 to 0.040 nationally, and 0.004 to 0.108 in the San Francisco Bay Area. Because Waymo's interval overlaps with New York City' FHVs', the data cannot rule out Waymo having a comparable KSI rate, nor can it rule out a substantially higher one. Given this, **these initial severe crash metrics warrant significant caution and further scrutiny**. Experts believe that it could take billions of miles driven before conclusive, definitive statements could be made.[17]

Further, the data obtained for New York City FHVs do not include a combined category for serious injury and fatalities. As a result, we summed serious injuries and fatalities in this analysis, which may double-count some KSI crashes if the crash had both a fatality and a critical injury. Therefore, this may inflate the KSI count for the city's for-hire fleet, and the gap may be even wider in favor of the human for-hire fleet.

Figure 1. Killed or Seriously Injured (KSI) Crash Rates



Sources: *NYC Taxi & Limousine Commission crash data (2025); NYC Department of Transportation VMT data (2025); Mayor's Office of Climate and Environmental Justice VMT data (2024); New York Police Department crash data (2024); Waymo crash and VMT data September 2020 through March 2026 (see* ***Appendix A1*** *for further data and methodology details).*

Injury-Causing Crashes

Table 2 shows that across all deployed locations nationally, Waymo reports 0.71 injury-causing crashes PMM, and in the San Francisco Bay area, reports 0.70 incidents PMM. Our analysis found that in the city in 2025, FHVs had 2.15 incidents PMM. This means that, in all deployed locations nationally and in the Bay Area, Waymo vehicles got into roughly one-third (33.2% and 32.6%, respectively) fewer injury-causing crashes PMM as compared to New York City FHVs.

> ***Waymos appear to be increasingly good in the types of streets and conditions they are currently deployed. It is not yet determined how these vehicles will perform in chaotic roadway conditions like New York City.***

Unlike the KSI analysis discussed above, this comparison includes a larger number of events for both the human and robotaxi fleets. **Figure 2** illustrates the relationships between confidence intervals for injury-causing crashes, showing that the intervals are much smaller for both Waymo and New York City FHVs. This, coupled with the difference in magnitude, gives us more confidence in preliminary numbers that Waymo's record for injury-causing crashes is better than a professional human fleet. However, we still believe more evidence is needed to make final determinations. One possible explanation is that Waymos appear to be increasingly good in the types of streets and conditions they are currently deployed. It is not yet determined how these vehicles will perform in chaotic roadway conditions like New York City.

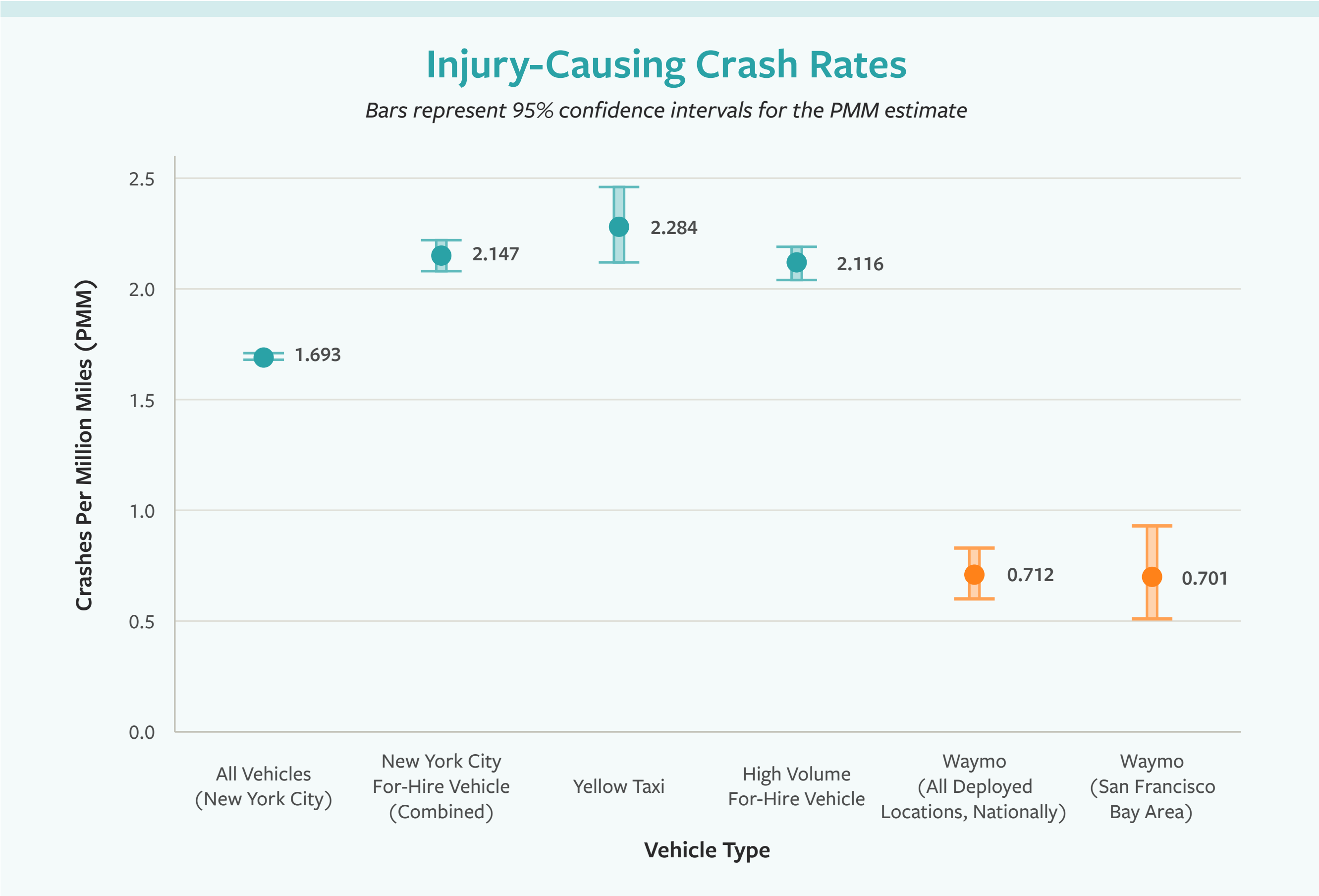
Table 2: Injury-Causing Crash Rates

Injury-Causing Crash Rates

Vehicle Type	Vehicle Miles Traveled	Injury-Causing Crashes	Injury-Causing Crashes Per Million Miles	95% Confidence Intervals
All Vehicles (New York City)	**24,462,691,033**	**41,410**	**1.69**	**1.68 – 1.71**
New York City For-Hire Vehicles (Combined)	**1,750,149,509**	**3,757**	**2.15**	**2.08 – 2.22**
Yellow Taxis	317,877,185	726	2.28	2.12 – 2.46
High-Volume For-Hire Vehicles	1,432,272,323	3,031	2.12	2.04 – 2.19
Waymo (All Deployed Locations, Nationally)	**220,613,000**	**157**	**0.71**	**0.60 – 0.83**
Waymo (San Francisco Bay Area)	67,078,000	47	0.70	0.51 – 0.93

Sources: *NYC Taxi & Limousine Commission crash data (2025); NYC Department of Transportation VMT data (2025); Mayor's Office of Climate and Environmental Justice VMT data (2024); New York Police Department crash data (2024); Waymo crash and VMT data September 2020 through March 2026 (see* ***Appendix A1*** *for further data and methodology details).*

Figure 2. Injury-Causing Crash Rates



Sources: *NYC Taxi & Limousine Commission crash data (2025); NYC Department of Transportation VMT data (2025); Mayor's Office of Climate and Environmental Justice VMT data (2024); New York Police Department crash data (2024); Waymo crash and VMT data September 2020 through March 2026 (see **Appendix A1** for further data and methodology details).*

It is important to note that everyday drivers are not required to report every contact that involves a suspected injury; professional drivers and Waymo vehicles are. This may be why everyday drivers appear to have fewer crashes than FHV drivers — because they are not required to report them.[18]

Overall, we find that Waymo's fleet has not yet driven enough miles to support that they are safer than FHV drivers.

VMT Analysis

California's Waymo robotaxi fleet generates unique and detailed operational data due to public reporting requirements to the California Public Utilities Commission (CPUC). This data set provides us with a rare empirical window into how robotaxis actually behave on public streets. It also allows us to create hypothetical robotaxi deployment scenarios in New York City and estimate potential VMT impact. Additionally, by comparing this data provided to the CPUC and data on New York City's HV-FHV fleet (e.g. Uber and Lyft) VMT provided by the Department of Transportation, we can make comparisons on how autonomous and human for-hire fleets impact VMT.

KEY FINDINGS

1. Replacing human-driven FHVs with robotaxis could increase total VMT. Waymo's deadheading rate (the amount of time a vehicle drives empty) exceeds New York City's existing high-volume for-hire fleet. **Waymo vehicles drive empty 41.6% of the time as compared to 33% for the city's human for-hire fleet.**
2. Waymo's VMT multiplier (total miles driven empty per passenger mile served) is 1.71, compared to 1.49 for New York City's existing HV-FHV fleet. This means that for every mile a passenger is onboard, Waymo vehicles drive .71 miles with no one in the car as opposed to .49 miles for HV-FHVs. **The 14.8% gap means that, at current rates, replacing HV-FHV trips with robotaxi trips would increase, not decrease, total VMT on city streets.**

VMT Data from California

In March 2026, Waymo completed 1,363,067 trips across its California fleet. Under California law, Waymo is required to report its VMT to the CPUC,[19] broken down into three operating phases:

- P1: Idle/Waiting for a Trip
- P2: En-route to Pick-up
- P3: Passenger Onboard

This phase breakdown allows us to better understand what Waymo vehicles are doing when they are doing it. For example, we can determine their "deadheading," or time spent without a passenger in the vehicle, by adding P1 and P2. Deadheading is the primary mechanism by which HV-FHVs add net VMT to city streets without moving people. **Table 3** contains travel classifications and statistics for Waymo vehicles in March 2026.

Deadheading is particularly impactful in urban areas. While an empty mile and an occupied mile impose similar per-mile costs on roadway congestion and safety, deadheading represents VMT added without any corresponding transportation benefit. Each empty mile driven is a mile of congestion, emissions, and crash exposure without a trip served. Robotaxis may also be prone to higher rates of deadheading simply because there is no human driver. Without a driver, there are no human constraints on operational hours like sleep, hunger, or bathroom breaks. In theory, robotaxis can operate for as long as their battery is charged.

Table 3: Waymo VMT Travel Classifications and Summary

Waymo VMT Travel Classifications and Summary

Travel Classification	Description	Miles Traveled by Waymo (% of their total VMT)
Idle / Waiting for Trip (P1)	Vehicle travel after completing a trip, before accepting the next one	2,434,465.45 (26.7%)
En Route to Pick-up (P2)	Vehicle travel from last drop off to next passenger	1,353,238.74 (14.9%)
Passenger Onboard (P3)	Vehicle travel with active trip & passenger on board	5,317,404.10 (58.4%)
Total VMT (P1 + P2 + P3)	Sum of all vehicle travel	9,105,108.29
Deadheading (P1 + P2)	Time spent driving without a passenger	3,787,704.19 (41.6%)
VMT Multiplier (Total VMT ÷ P3)	Total miles driven per passenger-carrying mile	1.71 *(i.e. for every mile driven with a passenger, 0.71 miles are driven empty)*

Sources: *Waymo via California Public Utilities Commission, VMT data for March 2026 (see* ***Appendix A1*** *for further data and methodology details).*

Translating to Per-Vehicle Behavior

To better understand the impact of a hypothetical fleet, we need to understand the impact of individual vehicles. Waymo does not directly report vehicle counts to the CPUC, or elsewhere. Therefore, we used a December 2025 report of 1,955 registered vehicles in California,[20] which we rounded up to 2,000, to estimate a per-vehicle daily performance (**Table 4**) for March 2026, which informs our hypothetical New York City scenarios.

Table 4: Waymo VMT Impact Per-Vehicle Per-Day in California, Assuming 2,000 Fleet Vehicles

Metric	Result[21]
Trips per vehicle per day	22.0
Total VMT per vehicle per day	146.9
Passenger (P3) VMT per vehicle per day	85.8
Deadhead VMT per vehicle per day	61.1

See ***Appendix A1*** *for calculations.*

New York City Fleet Scenarios

To understand the potential impacts on New York City's streets, we model two scenarios:

- **SCENARIO 1:** Robotaxis only add to New York City's HV-FHV trips, and do not displace any existing trips
- **SCENARIO 2:** Robotaxis displace and replace existing HV:FHVs 1:1

Further details on our methodology and sources are expanded on in this section, and in **Appendix (A1)**. We chose to conduct this section of our analysis using HV-FHVs only, instead of combining with taxis. This decision is expanded on in **Appendix (A2)**.

SCENARIO 1 Robotaxis Only Add to HV-FHV Trips

If Waymo robotaxis entered the New York City market without displacing any existing HV-FHV trips, the VMT impact would be straightforward: every robotaxi trip adds vehicle miles that did not previously exist (**Table 5**). Approximately 42% of those total miles would be empty.

Table 5: Incremental Trips and VMT from Robotaxis, Assuming No HV-FHV Displacement (Scenario 1)

Incremental Trips and VMT from Robotaxis, Assuming No HV-FHV Displacement (Scenario 1)

New York City Robotaxi Fleet Size	Trips/day (*veh count * 22.0*)	Added Total VMT/day (*veh count * 146.9*)	Added Empty VMT/day (*veh count * 61.1*)
500 vehicles	11,000	73,450	30,550
1,000 vehicles	22,000	146,900	61,100
2,000 vehicles	44,000	293,800	122,200

While the likelihood of Scenario 1 persisting in the long term is low, we believe it serves as a useful lens. Due to the novelty of robotaxis, we believe that a robotaxi company's launch would result in a net increase in total rides; riders would be interested to try a new technology, and may substitute other means of travel (biking, walking, public transportation) to try it out, thereby adding robotaxi trips. Further, in an earnings report, Uber explicitly says that they believe that robotaxi growth will result in "incremental growth for the entire category."[22]

More than anything, Scenario 1 creates an upper bound on VMT impact, and illustrates that even a modestly sized robotaxi fleet generates substantial empty driving. **A fleet of just 500 vehicles would add over 73,000 vehicle miles per day to city streets — including over 30,000 empty miles, the equivalent to 938 trips around Manhattan a day.**

SCENARIO 2 Robotaxis Replace Existing HV-FHV Trips 1:1

Our second scenario takes into account the potential share of the market that Waymo would take from HV-FHVs, which are on-demand ride services (e.g. Uber, Lyft) that serve essentially the same function as Waymo. The critical question we address is whether robotaxi trips generate more or less VMT than the HV-FHV trips they replace. In this analysis, we assume Waymo vehicles would replace HV-FHVs 1:1. Like Scenario 1, we do not believe that demand replacement will be exactly 1:1. However, it is a helpful way to analyze potential replacement impacts.

VMT Multiplier

The VMT multiplier is the number of total vehicle miles traveled for every passenger-carrying mile, capturing the deadhead miles driven between fares.

Table 6 compares VMT metrics for both city HV-FHV and Waymo vehicles. New York City Department of Transportation data from 2025 shows that the human-driven HV-FHV fleet had a citywide utilization rate of 67%, implying a deadheading share of 33% — meaningfully lower than Waymo's 41.6% deadheading rate for March 2026. With this, we can compare the two fleets on multiplier terms:

Table 6: Empty VMT Comparisons, New York City High-Volume For-Hire Vehicles vs. Waymo (Inputs for Scenario 2)

Empty VMT Comparisons, New York City High-Volume For-Hire Vehicles vs. Waymo (Inputs for Scenario 2)

Metric	New York City High-Volume For-hire Vehicles (Citywide, 2025)	Waymo (California March 2026)	Difference
Empty Share of Total VMT	33.0%	41.6%	+8.6 percentage points
VMT Multiplier	1.49	1.71	+0.22 (+14.8%)
Empty Miles Per Passenger Mile	0.49	0.71	+0.22 (+14.8%)

Sources: *Waymo via California Public Utilities Commission, VMT data for March 2026; NYC Department of Transportation VMT data (2025) (see* ***Appendix A1*** *for further data and methodology details).*

The 0.22 gap in multipliers is critical: for every passenger mile shifted from an existing city HV-FHV to a Waymo vehicle, approximately 0.22 additional vehicle miles would be driven — an increase of almost 15% in total VMT per passenger mile served. This holds regardless of whether New York City trips are longer or shorter than Waymo's California average. **If the Waymo multiplier remains above the city's HV-FHV multiplier, there will be an increase in total VMT per passenger mile served.**

As it stands, replacing a HV-FHV with a robotaxi would increase VMT and congestion.

Parking & Curb Analysis

A crucial matter often overlooked when discussing robotaxis is their potential impact on the curb. In California, Waymo reports data on miles driven but not on time spent parked. However, using a formula devised by Dr. Matthew Raifman, a UC Berkeley transportation researcher, we can estimate how long Waymo vehicles spend parked waiting for their next ride. By doing this, we can better understand potential impacts on the curb, parking, and congestion.

KEY FINDINGS

1. **New York City's constrained parking supply would likely dramatically increase Waymo's deadheading if deployed in the city, leading to more traffic and wear on the streets.** We estimate that Waymo vehicles spend over half their waiting time parked in California. Our analysis finds that every 1% decrease in parked time would result in a 1.5% increase in deadheading; for example, if Waymo vehicles were only able to park 33% of the time while waiting for a ride in California (instead of the approximated 58% they spend parked today), their deadheading would increase by 37%.
    a. This increase in P1 mileage means that overall deadhead miles (travel without a passenger, either idle or en-route to a pickup) would increase by 1.5% for every 1% decrease in parked time.
2. In California, Waymo vehicles spend an estimated 57.7% of their waiting time parked: about 10.4 minutes per trip according to our calculations. **This means that each vehicle in the fleet needs to be parked on-street while waiting between rides for about four hours a day.**

Waymo Parked Time in California

Data reported by Waymo to the CPUC — miles traveled waiting for a ride (P1) and time waiting in between rides — allows us to estimate how much time Waymo's fleet spends parked waiting for a ride. Dr. Raifman determined that by dividing Waymo's P1 VMT share (their time spent waiting before or after a ride) and an assumed miles per hour driven (14 mph), we can calculate the hours of P1 that vehicles spend moving.[23] Then, by subtracting Waymo's total waiting time and their P1 moving time, we can estimate their parked time. Deriving parked time by this method is necessary because Waymo does not provide public data about their parking habits. Further details on our methodology and sources are included in **Appendix (A1)**.

Dr. Raifman estimated that the average Waymo vehicle spent approximately 53.3% of its waiting time (P1) in September 2025 parked rather than moving. Applying the same methodology to the March 2026 data yields an even higher share of parked time, as shown in **Table 7**:

Table 7: Estimated Waymo Parked Share in California

Estimated Waymo Parked Share in California

Metric	March 2026
Parked Share (Share of P1 time spent parked)	57.7%
Estimated parking time per trip	10.4 min

*See **Appendix A1** for calculations.*

Waymo vehicles spend more than half of their between-trip time standing still, presumably parked.

Table 8: Estimated Waymo Fleet Parking Behavior

Estimated Waymo Fleet Parking Behavior

New York City Robotaxi Fleet Size	Trips/Day (*veh count * 22.0*)	Hours/Parking (*Trips * 10.4 minutes*)
500 vehicles	11,000	1,907
1,000 vehicles	22,000	3,813
2,000 vehicles	44,000	7,627

Implications for New York City

Using this estimate, we can understand two key metrics: the parking needs of different sized fleets and the impact on VMT if parking is unavailable.

If a hypothetical New York City Waymo fleet maintained the same parked-time behavior observed in California, the curb space demand would be substantial, requiring each vehicle to be parked for about four hours a day (**Table 8**).

However, we are doubtful that parked share in New York City would be similar to California's parked share (57.7%). Parking availability, especially in the most dense, high-demand areas for FHVs (like the Central Business District in Manhattan), is extremely constrained. Therefore, it's important for us to look at the potential VMT impacts of a lower parked share during P1 (idle time), which would result in more deadheading VMT.

Table 9 estimates how both idle time and overall deadheading would change if Waymo's parked share of waiting time fell below its California baseline of 57.7%. By reversing the tactic used to devise parked share, we can estimate the following:

Table 9: Reduced Park Share Deadheading Scenarios

Reduced Park Share Deadheading Scenarios

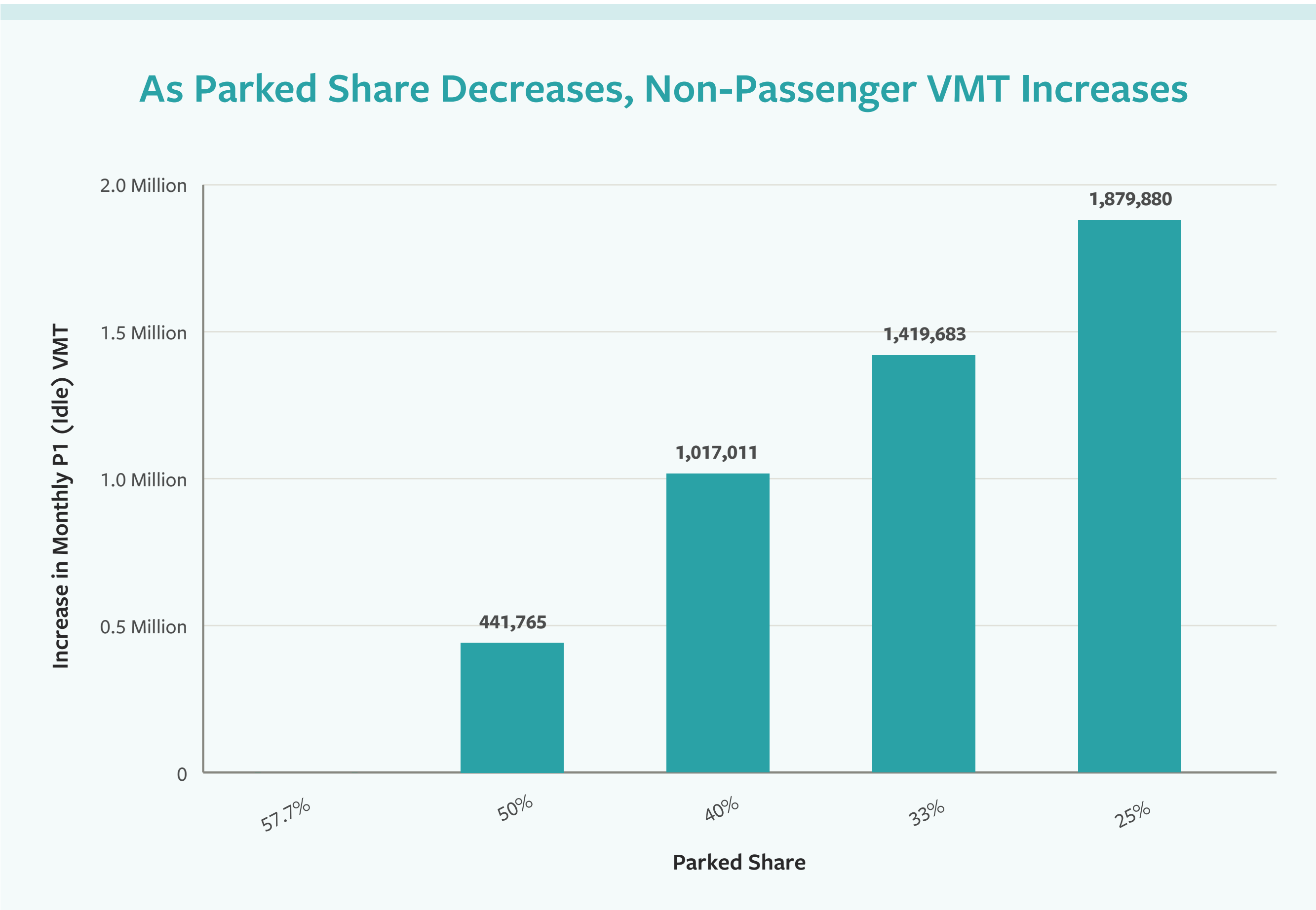
Parked Share	Waiting Hours Parked	Increase in Monthly P1 (Idle) VMT	Increase in P1 (Idle) VMT (%)	Increase in Deadhead VMT (%)
California Baseline (57.7%)	237,000	—	—	—
50%	205,445	441,765	18%	12%
40%	164,356	1,017,011	42%	27%
33%	135,594	1,419,683	58%	37%
25%	102,723	1,879,880	77%	50%

Sources: *Estimated from Waymo data via California Public Utilities Commission, Wait Time and VMT data for March 2026 (see* ***Appendix A1*** *for further data and methodology details).*

Figure 3 plots this relationship, showing that as vehicles spend less time parked and more time circulating while waiting for a dispatch, idle VMT rises.

If parked share decreases, deadheading VMT would increase sharply. For every 1% decrease in parked share, there is roughly a 2.4% increase in P1 VMT and a 1.5% increase in deadheading, assuming all else remains the same. Our findings are in line with other research that found that banning robotaxis from staging at the curb would result in significant VMT increases.[24] Both scenarios — banning robotaxis from the curb and allowing them to freely use the curb — would create complex issues at the curb. Robotaxis leave a significant footprint on a city's streets and curbs.

Figure 3: Relationship between Parked Share of Waiting Time and Increases in Monthly P1 (Idle VMT)



Baseline waiting hours parked = 237,000. VMT increase calculated relative to baseline.

Data Considerations

The calculations done in this paper are assembled with publicly available data and data that has been obtained from the NYC DOT and the NYC TLC. Waymo did not respond to our multiple requests for additional data.[25] We chose to use Waymo data for our analysis because they have the most robust publicly available data due to California requirements and the size of their fleet. Though Waymo does provide some data that is not required by any governmental authority, key data points are still missing. As a result of these gaps in the data, the scope of this study is limited to the questions addressed. With additional data, we (and other researchers) could conduct further in-depth research. Some of the data gaps include:

- **A lack of localized, aggregated VMT data.** If aggregated VMT data were available at the city level (i.e. San Francisco), it would allow a closer apples-to-apples comparison of citywide VMT. Instead, we have to rely on state-wide data mandated by the California Public Utilities Commission (CPUC).
- **A definitive total number of Waymo vehicles operating in a given city or state.** Access is limited to numbers periodically shared with Waymo shareholders or reported in the press. Fleet size is directly tied to any assessment of operational efficiency.
- **The amount of time Waymo vehicles spent parked, double parked, or otherwise parked in violation of parking regulations.** We can only estimate parked time. Quantified parked time matters for understanding potential impacts on curb management.
- **The number of daily hours Waymo vehicles operate, individually or fleet wide.** Without precise numbers, it is challenging to fully understand VMT impacts.

Some of these data gaps are not strictly related to Waymo; there are also gaps in the New York City FHV data. For our analysis, the important gap is how long FHVs in the city are parked. And for localities outside of New York City (including San Francisco), there is limited data on FHV behavior in order to make a comparison to other for-hire fleets.[26] However, as a result of robotaxis being a fully autonomous fleet, the capture and dissemination of such data is significantly easier than for other kinds of FHVs.

These gaps notwithstanding, with robotaxis launching in cities around the country and the globe, it is essential we use the data that we do have in order to spur analysis, thought, and debate.

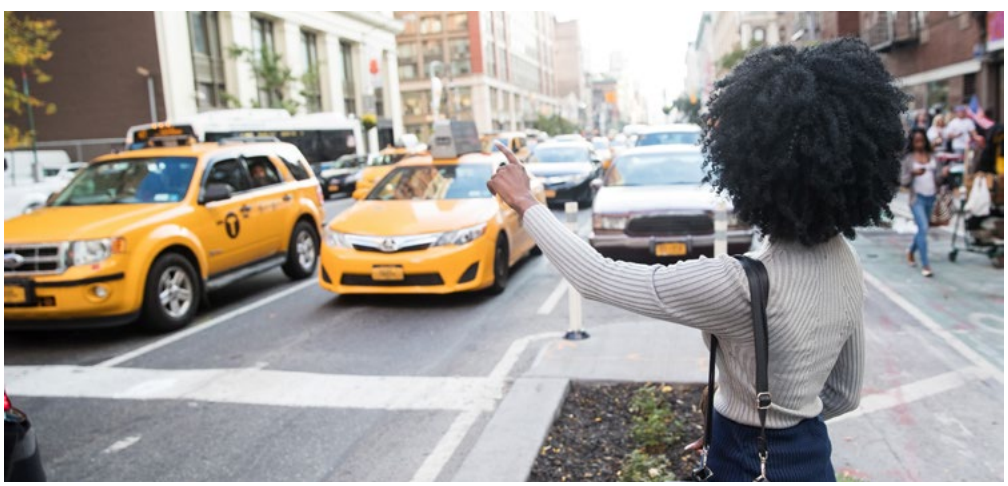
Policy Implications

Our research raises important questions for policymakers. These results further complicate if and when New York City — or any dense, urban environment — should allow robotaxis. Below, we name further considerations informed by our analyses.

1 There will be additional impacts on VMT and congestion.

While we touch on a number of potential impacts on VMT in our analysis, there are also others that require further investigation and research.

- **Where would robotaxi depots be placed, and how often are Waymo vehicles going to and from the depots for charging, cleaning, and maintenance?** In the current VMT data, mileage for returns to depots are not included; these would be additional deadheading miles, and potentially some of the most negatively impactful miles. If robotaxi depots are placed in New Jersey or in the outer boroughs, the added congestion on bridges and tunnels could diminish the positive impact of congestion pricing. Further, depot placement could have negative impacts on those near the depot including added congestion and noise.
- **How would robotaxis' parking behavior impact our streets and curbs?** How would frequent pulling in and out of parking spaces impact congestion on our streets? Would buses be delayed by Waymo vehicles leaving or entering parking spots? If we allow robotaxis in loading zones (like Neighborhood Loading Zones), would that reduce the effectiveness of the loading zones? How would cyclists be impacted? While many of these same questions exist for vehicles of all types, it is a meaningfully different question; robotaxis' parking behavior is entirely determined by policy and programming.
- **How would induced demand impact VMT?** In practice, lower fares and service proliferation may grow the total ride-hail market, attracting riders who currently walk, bike, or take transit. This could also impact road-user safety. Public transit is currently safer than any FHVs or robotaxi, so pulling riders from transit to robotaxis would have an overall negative impact on safety.



2 We already have technology and infrastructure that make cars and streets safer.

We have existing technologies and street design techniques that increase safety without the host of questions robotaxis introduce. With respect to vehicle safety technology, advanced driver assist systems have proven to reduce crashes of all types: forward collision warning and automatic braking cuts rear-end crashes in half, automatic braking for pedestrians cuts crashes by 27%, and blind spot detection reduces lane-change crashes by 14%.[27] Some of these technologies are required by the National Highway Traffic Safety Administration (NHTSA) in new vehicles, but not all.

The best way to improve safety on our streets is by designing them for safety. By designing streets to reduce and prevent speeding, putting in place bus and bike lanes to encourage transit and bike use, and implementing other interventions like curb extensions, hardened daylighting, and road diets, we can make our streets safer with tools we already have in our toolbox.

3 The benefits of fleet operations are contingent on corporate monopoly or good regulation.

Aside from purported and potential safety benefits of robotaxis, a factor that proponents often cite is the benefit of having a fleet of vehicles that “talk” to each other, especially for safety reasons. For example, if there’s an emergency and an area is blocked off, the entire fleet can be immediately notified and avoid that area. Robotaxis can also communicate with each other to synchronize pick ups and drop offs.

However, that is only true in two circumstances: if a single company holds a monopoly and operates all robotaxis in a city (which may have harmful impacts on consumer choice), or if State and City regulators require companies to share fleet data, creating a truly unified network. **Without regulations mandating this kind of data sharing, we could end up with a fragmented system where operators only coordinate their own vehicles.** Each company would optimize its own fleet in isolation, with no visibility into what competitors are doing at the same curb, intersection, or block. The result is a patchwork of siloed fleets behaving less like a coordinated network, with more competition for the same limited street space – arguably no better than the coordination problems with our existing for-hire fleet, despite the technology’s potential to improve information sharing.

Policy Recommendations

It is still unclear whether robotaxis will be a net benefit to New York City; this research introduces further questions. However, it's important that our city is prepared to consider their adoption and to mitigate their potential negative effects. Based on our analyses, we present several recommendations for New York City (and other governments) to take into account and implement.

1 Require robotaxi companies to compare their safety data to professional, FHV drivers as a prerequisite to licensure to operate

Everyday drivers will not be directly replaced by robotaxis — professional, FHV drivers (e.g., drivers of taxis, Ubers, and Lyfts) will. In New York City, FHV drivers have serious or fatal crashes at a rate 14-times less than all drivers; they should be the benchmark comparison. It is critical that DOT, through partnership with TLC, require robotaxi companies to compare their purported safety benefits to our city's FHV drivers as a prerequisite to receive operating licenses. They should be at least as safe, if not safer, than these drivers. Those studies should be peer-reviewed by recognized, independent bodies in the traffic safety field.

2 Require data transparency from robotaxi companies to properly conduct critical analyses

Due to the fleet-based nature of robotaxis, companies are able to collect data at an unprecedented scale and granularity. In our **Data Considerations** section, we identify gaps in publicly available data that limited the scope of our analysis. New York City (and other governments) should require robotaxi companies to provide the following information for analysis, to close existing data gaps:

- Localized VMT data, especially for dense, urban areas like San Francisco
- VMT data for non-service phases, such as mileage spent returning to depots or offline
- Depot location and time spent at depots charging, parked, or receiving service
- The total number of robotaxi vehicles operating in their fleet nationally, and in each state, locality, and operating area
- The amount of time each vehicle in their fleet spends parked: legally and illegally (including whether it is double parking, parking at the curb in an illegal space, or in a bike or bus lane). This information should also be required from citywide for-hire TLC fleets.
- The number of daily hours each vehicle in their fleet operates
- The number and type of near-misses their vehicles have[28]

If deployment is eventually approved, these same data requirements should continue on an ongoing basis, so that the State and City can properly monitor and assess impacts over time. This should include, but is not limited to: regular, standardized reporting on crash and near-miss incidents, real-time or periodic VMT and deadheading figures, curb and parking violation data, and the geographic distribution of trips and vehicle activity across neighborhoods, to track whether impacts are concentrated in specific areas over time.

3 Prepare fees to adequately capture and reduce the impact of robotaxis on our streets

In our VMT and parking analyses, we found that the potential traffic impact of robotaxi fleets is significant. To adequately put a price to these externalities, New York City should consider one or a combination of all of the following:

1. **A vehicle miles traveled fee**, which would be levied for every mile a robotaxi drives. New York City should determine the fee that would best discourage excess miles, and a higher fee for miles that are spent deadheading. Such a policy is not unprecedented; the District of Columbia Council, for example, recently introduced a bill which included a VMT fee for robotaxis.[29]
2. **A vehicle hours fee**, which would charge robotaxi operators based on the total time a vehicle occupies a given highly congested zone (like the Central Business District), whether it is moving, idling, or parked illegally. By pricing total time in the zone rather than distance traveled, the fee would create a direct financial incentive for operators to minimize dwell time within the congested areas, including repositioning to lower-demand areas outside the zone. A vehicle hours fee would be levied in place of a VMT fee in applicable areas; they would not double up. Time-based charges are already deployed in some capacity by the TLC for driver-pay formulas.[30]
3. **Parking and curb use fees**, which would properly price robotaxis' potential impact on our curbs. At the very least, it's important for New York City to identify how to charge robotaxi companies for use of metered spots. After a more thorough analysis, the City should also determine whether robotaxi companies should be charged for all uses of the curb, whether they occupy a paid or "free" spot. Companies are already integrating robotaxi metered parking payment, and organizations like the Open Mobility Foundation are developing digital tools to assist cities in a robotaxi launch.[31]

4 Stop centering single-use vehicles and consider how automated public transit can fill holes in our transit system

We cannot fall into the trap of only centering single-use vehicles, as so many transportation planners and experts have for decades. While debate about the merits of robotaxis is important, it's perhaps more important to discuss and consider how this generation-defining automated technology can be used for the public's benefit, and not just for corporate benefit.

Automated public transportation is already being used across the country and globe. Atlanta, Georgia is running an automated shuttle pilot, and closer to home, the Port

Authority of New York and New Jersey is piloting automated airport shuttles.[32] Early research suggests it is possible to benefit from this technology without losing jobs.[33] It is important to consider how New York City can leverage this technology to increase service and close gaps in our transportation system.

5 Consider limiting robotaxis' ability to travel within dense, transit-rich commercial areas

Robotaxis stand to add millions of miles annually to our streets. We do not need more vehicles entering highly dense, transit-rich commercial areas like Midtown Manhattan, the Financial District, or Downtown Brooklyn. This is particularly true for areas in the Central Business District, where massive gains have been made in reducing congestion due to congestion pricing. The City should consider whether robotaxi travel should be limited (also known as geofencing) within certain commercial areas, similar to the limited geographic scope of green cabs, to prevent congestion. Geofencing could also encourage robotaxis to fill transit gaps, by directing service towards areas with poor transit access.

6 Expand FHV pick-up/drop-off zones

Robotaxis have the potential to greatly disrupt our already-chaotic curb landscape. New York City should implement more dedicated FHV pick-up and drop-off zones, regardless of whether robotaxis deploy in our city, to avoid illegal and double parking. If they do, the NYC Department of Transportation should consider how robotaxis would interact with these and other loading zones. Would they need dedicated, robotaxi pick-up/drop-off zones or parking? Would they be permitted to use Neighborhood Loading Zones like human FHV drivers are today? How would robotaxis be fined if they violate parking laws? These are important questions that will shape our curbs in the decades to come, but the answer begins with more pick-up/drop-off zones.

7 Manage licensing and control deployment to prevent excessive robotaxi VMT growth

We find that robotaxis carry a higher VMT multiplier than New York City FHVs, with more deadheading without a passenger. Without a driver, there are no human constraints on operational hours like sleep, hunger, or bathroom breaks. In theory, robotaxis can operate for as long as their battery is charged. Without a mechanism to manage growth, robotaxi deployment risks adding net VMT and congestion to city streets. If deployed in New York City, the City should study the actual net VMT impact of robotaxi deployment relative to existing FHV activity on our streets and manage licenses, including a potential fleet cap, to prevent an increase in VMT.

APPENDIX A1

Further Details on Methodology & Data Sources

Safety Analysis

For each fleet, the numerator (crash incident count) and denominator (VMT) come from the same reporting period, so each individual rate is internally consistent. Comparing rates across different reporting windows doesn't undermine the validity of the per-mile rates themselves, since each rate is normalized by that category's own exposure (miles driven). However, the sources for each base statistic vary:

VMT:

- **NYC Taxis & High-Volume For-Hire Vehicles:** 2025 Citywide VMT provided by the New York City Department of Transportation. This data is derived from an analysis of New York City Taxi and Limousine Commission Taxicab Passenger Enhancement Program (TPEP) for Yellow Taxis and HV-FHV (Uber, Lyft) breadcrumb data. This data set was provided to the Sam Schwartz Transportation Research Program directly.
- **Waymo:** VMT provided by Waymo, capturing all driverless miles driven (which Waymo refers to as 'rider-only,' meaning there is no driver in the car) since service launch in September 2020 through March 2026. Available publicly.[34]
- **All New York City Vehicles:** VMT provided by the New York City Mayor's Office of Climate and Environmental Justice (MOCEJ) for 2024. Sum of VMT for all vehicles (buses, school buses, FHVs, trucks, and public and private passenger cars). Available publicly.[35]

Crash Incidents:

- **NYC Taxis:** 2025 crash data reported under New York City Local Law 31. Available publicly.[36]
- **NYC High-Volume For-Hire Vehicles:** 2025 crash data supplied by the New York City Taxi and Limousine Commission. Because TLC-licensed vehicles can serve the traditional FHV industry, the high-volume (Uber/Lyft) industry, or both, TLC built this figure from raw New York Police Department (NYPD) crash records. This aggregation is not routinely produced, because the NYPD categories differ from the Local Law 31 categories. TLC matched the vehicle plate on each crash record to its internal records on vehicles and trips, associating each crash to the high-volume industry where the vehicle had completed a high-volume trip in the month of the crash. This data set was provided to the Sam Schwartz Transportation Research Program directly.
- **Waymo:** All crash incidents from Waymo's publicly supplied data, capturing every reported incident during driverless operations since launch in September 2020. The latest update at the time of this report included data through March 2026. This data is based on reporting required by the National Highway Traffic Safety Administration (NHTSA) Standing General Order (SGO).[37]
- **All New York City Vehicles:** 2024 crash data from NYPD, available publicly.[38] While NYPD data directly indicates crashes resulting in injuries or fatalities, it does not directly classify serious injuries. Serious injuries are defined based on the New York City Department of Transportation's categorization, which follows New York State law. To determine which crashes resulted in serious injuries, we applied a modified New York State Department of Motor Vehicles (NYS DMV) severity formula (provided by NYC DOT) to the NYPD crash data. This aligns the NYPD data form to the NYS DMV definition of Severe Injury, to the extent that the necessary fields are complete and accurate in NYC Open Data. The formula captures: Injuries resulting in emotional state: 'Unconscious', 'Semiconscious', 'Incoherent', and injuries resulting in complaint: 'Amputation', 'Concussion', 'Internal',' Severe Bleeding', 'Moderate Burn', 'Severe Burn', 'Fracture - Dislocation', 'Fracture - Distorted - Dislocation', 'Crush Injuries', 'Paralysis', 'Severe Lacerations'.

Calculations:

Crashes Per Million Miles (PMM) = (Crashes / VMT) * 1,000,000

Exact (Garwood) Poisson Confidence Intervals

Bounds were calculated in Excel using the chi-square distribution, at the 95% confidence level, where **x is the observed count of crashes**. The resulting bounds represent the 95% confidence interval for the expected count and are then divided by the relevant exposure measure (vehicle miles traveled) to produce the rate confidence interval reported in the study.

Upper bound (per million VMT): =0.5*CHISQ.INV(0.975, 2× x+2)/(VMT/1,000,000)

Lower bound (per million VMT): =0.5*CHISQ.INV(0.025, 2×x)/(VMT/1,000,000)

VMT Analysis

VMT:

- **NYC Taxis & High-Volume For-Hire Vehicles:** same VMT source as the Safety Analysis.
- **Waymo:** Under California law, Waymo is required to report vehicle miles traveled to the California Public Utilities Commission (CPUC) as part of Deployment Program Quarterly Reports. This data is available publicly on the CPUC website.[39] For our analysis, we used the most-recent available month (March 2026) of the latest quarterly report at the time of publication, 2026 Q1 (Reporting Period: January 1, 2026 – March 31, 2026).
  While the names of the files can vary between reporting periods, VMT data for this report was found in the file named 'PSG0038152_2026_05_AV_Month_Part0-Deployment.csv'.

Calculations:

Multiplier = Total VMT ÷ P3 (On-Trip) VMT

Trips per vehicle per day = Total Trips per Month ÷ Total Vehicles ÷ Days per Month

Total VMT per vehicle per day = Total VMT per Month ÷ Total Vehicles ÷ Days per Month

Passenger (P3) VMT per vehicle per day = Total P3 VMT per Month ÷ Total Vehicles ÷ Days per Month

Deadhead VMT per vehicle per day = {P1 + P2) VMT per Month ÷ Total Vehicles ÷ Days per Month

Parking Analysis

"Parked share" is an estimate based on an analysis method developed by Dr. Matthew Raifman, a UC Berkeley transportation researcher studying how automated vehicle systems affect safety, sustainability, and urban mobility. His original description of his methodology is available online.[40]

VMT:

- **Waymo:** same VMT source as the **VMT Analysis**. The quarterly reporting required by CPUC also requires Waymo to submit information on Total Waiting Time, or the total amount of time vehicles waited between ending one passenger trip and initiating the next passenger trip, expressed as a monthly total in hours, in the same CSV as the other VMT data.

Calculations:

P1 Waiting Time Moving (Hours) = P1 VMT ÷ Assumed Miles per Hour

P1 Waiting Time Parked (Hours) = Total Waiting Time (Hours) - P1 Waiting Time Moving (Hours)

Share Time Parked = Total Waiting Time ÷ P1 Waiting Time Parked (Hours)

Time Parked Per Trip (Minutes) = (Total Trips ÷ P1 Waiting Time Parked (Hours))*60

APPENDIX A2

Omitting Taxis from VMT & Parking Analyses

We chose to omit taxi data from our VMT and parking analyses and include it in the safety analysis. This is due to a number of reasons.

With respect to our VMT and parking analysis:

Taxis have dissimilar driving patterns to HV-FHVs, and therefore, to robotaxis. Taxis get a significant amount of their fares and passengers by scouting the streets, resulting in a disproportionate amount of deadheading. HV-FHVs are solely dispatched to passengers through an app, like robotaxis are, and therefore do not have the intrinsic share of deadheading that taxis have. Therefore, we believe it would be inaccurate to compare the VMT impacts of taxis to Waymo vehicles or other robotaxis for the purposes of our analysis.

We believe that the type of FHV that will be most displaced by robotaxis will be HV-FHVs. This is because, due to the above reasons, they are much more similar to each other than taxis are to robotaxis. They serve a different (though sometimes overlapping) purpose as compared to HV-FHVs. However, we would be remiss to note that it is possible that robotaxis could more directly displace taxis through the purchase of taxi medallions, either from drivers themselves or the corporate entities that now own many licenses. However, whether this option would be pursued by legislators or companies is difficult to say.

Nevertheless, for the sake of transparency, we have included below the basic statistics (**Table 10**) of taxis as it relates to our VMT analysis.

With respect to our safety analysis:

Our goal with the safety analysis is to compare the safety records of Waymo vehicles in California and professional, for-hire drivers in New York City. For this purpose, their deadheading and methods through which they pick up passengers isn't important. The important factor is that they are professionals, driving for a living, licensed by the TLC.

Table 10: Taxis & Waymo VMT Multiplier

Taxis & Waymo VMT Multiplier

Metric	NYC Yellow Taxi	Waymo (California March 2026)	Difference
Empty Share of Total VMT	58.8%	41.6%	-17.2%
VMT Multiplier	2.43	1.71	-0.72 (-29.5%)
Empty Miles Per Passenger Mile	1.43	0.71	-0.72 (-29.5%)

Sources: *Waymo via California Public Utilities Commission, VMT data for March 2026; NYC Department of Transportation VMT data (2025). (see* ***Appendix A1*** *for further data and methodology details).*

APPENDIX A3

Waymo & New York City For-Hire Vehicle Fatalities

Because our serious-outcome (KSI) analysis is inclusive of fatalities, we did not include isolated fatalities within the analysis itself. We are providing the statistics below in **Table 11** for transparency:

Fatalities

Table 11: Fatal Crash Rate, Including Taxis

Fatal Crash Rate, Including Taxis

Vehicle Type	VMT	Fatalities	Fatalities Per Million Miles
All New York City Vehicles	**24,462,691,033**	**252**	**0.010**
New York City For-Hire Vehicle (Combined)	**1,750,149,509**	**15**	**0.009**
Yellow Taxi	317,877,185	4	0.013
High-Volume For-Hire Vehicle	1,432,272,323	11	0.008
Waymo (All Deployed Locations, Nationally)	**220,613,000**	**2**	**0.009**
Waymo (San Francisco Bay Area)	67,078,000	1	0.015

Sources: *NYC Taxi & Limousine Commission crash data (2025); NYC Department of Transportation VMT data (2025); Waymo crash and VMT data, September 2020 through March 2026 (see* ***Appendix A1*** *for further data and methodology details)*

ENDNOTES

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