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Assessing the Transformative Influence of Ride-Hailing Applications on Urban Mobility Patterns

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Abstract

The transformative influence of ride-hailing applications on urban mobility patterns is a critical aspect of contemporary transportation research. This study investigates this phenomenon through an assessment of New York City's (NYC) transportation landscape, focusing on the impact of ride-hailing services such as Uber and Lyft on traditional mobility patterns. We conducted a comprehensive analysis of NYC trip data, encompassing various transportation modes including yellow and green taxi services, public transit options like the subway and bus, and Citi Bike bicycle rentals. Our findings reveal a notable increase in the usage of ride-hailing services over the past decade, alongside a concurrent decline in yellow and green taxi usage. Moreover, we observe significant shifts in travel behavior, particularly during the COVID-19 pandemic, with ride-hailing services rebounding faster than traditional taxi services. These findings highlight the evolving dynamics of urban mobility and underscore the need for policymakers, urban planners, and transportation stakeholders to adapt to these changes. In addition to providing an understanding of the ongoing transformation of urban transportation systems, this research will assist in making informed decisions and developing effective strategic plans. Stakeholders can develop more responsive and sustainable urban mobility strategies by understanding the nuanced interactions between ride-hailing services and traditional modes of transportation.

Keywords: Open data, Data analysis, Ride-Hailing, Urban Mobility, Transportation Patterns, COVID-19 Impact

1. INTRODUCTION AND LITERATURE REVIEW

There are countless ways to get around in New York City, from yellow taxi cabs to apps like Uber and Lyft. Yellow taxis have been used by commuters for decades, but yellow taxi cabs have had recent challenges, most significantly the barrier to entry for many years: a driver required a special license, called a taxi medallion, or more recently, a Certificate of Public Necessity and Convenience (CPNC) (Jacobs, 2021, p. 172). Soaring medallion prices led to making it difficult for drivers to sustain their livelihood, which has kept a lot of active drivers from the business.

The COVID-19 pandemic worsened the prevailing challenges in the taxi industry. A 2021 poll conducted by the New York Taxi Workers Alliance found that nearly half of the drivers themselves either got the virus or had a family member get the virus (Rosenthal, 2020, lines 34-35). While the pandemic challenged the traditional taxi industry, ride-hailing apps Uber and Lyft seemed to recover more quickly to pandemic induced drops.

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This resilience can be attributed to the convenience perceived to be provided by ride-hailing services, coupled with adaptability to changes in circumstances. Following the rise of applications for ride-hailing, some taxi companies began to modernize by building app-based technologies. So far, a handful of companies have introduced fully-fledged app-based solutions to effectively compete with ride-share companies.

New York City has put in place regulations that will soften the influence of ride-hailing services (Joshi, 2019, pp. 9-12). In 2018 New York was the first major city in the United States to cap Uber and other app-based ride-hailing services. Some of the other policies introduced are those favoring ride-hailing companies, for instance, granting access to prime parking lots in the heart of the city. Urban transport is witnessing a sea change with traditional cabs reeling under the dominance of ride-hailing applications. Now, this is not to say that taxis are a thing of the past, but app-based services have made life hard for them and reduced their market share. Meanwhile, the future of urban mobility is shaped by a mix of regulatory interventions and technological advances, especially in how people move and what transportation offers will be available to the city's residents and visitors.

Technology has played a crucial role in the expansion of the overall economy, specifically when mentioning the mobile economy. Technology has facilitated the advancement of all sectors within a mobile economy, as a society that is more connected to one another does not always need an intermediary actor. This made it easier for consumers to demand rides directly on their phones and enhance the user experience via an application. Technology has decreased the matching time between the consumer and the driver, increasing the overall quality of the service.

It is possible to track the car and look at the driver's profile, and his or her rating through ride-hailing apps. This brings a sense of safety because it gives one an idea of who is driving them in the car. The latest technology allows the passenger to share details of the ride with their loved ones through the app, which makes them able to monitor the trip. Safety issues have always been common in the taxi industry; passengers enter a car with a stranger. Ride-hailing services have helped to allay this concern, by which they differ from the traditional taxi service and help dominant market share.

Critics of ride-hailing safety argue that the different regulations, from less rigid vehicle insurance to fewer criminal background checks, with less rigorous vehicle inspections, drive down the overall safety levels for consumers. However, many individuals feel more secure with ride-hailing, as the apps themselves are more transparent through the tracking features built into them (Salleh et al., 2024, p. 877).

In contrast, the safety of ride-hailing drivers appears to have improved compared to traditional taxi drivers. Quite often, taxi drivers operate at a high level of safety risk because they usually handle a lot of cash, which makes them prime targets for robbery. On the other hand, the systems of payment for a ride-hailing app are strictly in-application, thus reducing the risk of theft.

The taxi industry cannot keep up with this competition because of the financial burden of these expensive medallions, which are often very expensive in some cities. The financial burden placed by the expensive medallions on cabs puts them in a losing situation in terms of outclassing flexibility and technological advancements in the ride-hailing services field.

Another benefit to using ride-hailing is that it possibly contributes positively to the environment. The use of GPS information to combine passengers going in the same direction can lead to more efficient use of auto-based transportation. A reduction in the number of single-occupancy car trips could contribute to lowering total emissions and consequently reducing congestion.

2. METHODOLOGY

The data for this project was obtained through public, open source repositories. Data for yellow and green taxis were obtained from the TLC Trip Record Data website, https://www.nyc.gov/site/tlc/about/tlc-trip-record-data.page. Ride-hailing apps data came from the NYC Open Data platform, https://www.nyc.gov/site/tlc/about/tlc-trip-record-data.page. Citi Bike patterns were visualized using data from the Citi Bike NYC website, https://citibikenyc.com/system-data. MTA Bus and Trains patterns were visualized using Data from the MTA open data site, https://new.mta.info/open-data. Pandas facilitated data manipulation and analysis, while Matplotlib enabled the creation of various visualizations.

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The data for this project was available for download as CSV files. The data across the different transportation modes was adjusted to account for differences in the timing and measurement of trips. In many cases the downloaded files contained extra data not relevant to this study. That data was removed, and the relevant information was combined into a Pandas dataframe.

Pandas (https://pandas.pydata.org) is a widely-used Python library for data manipulation and analysis, offering efficient and expressive data structures like Series and DataFrame.

We also used Matplotlib (https://matplotlib.org) to create visualizations. Matplotlib's high level of customizability allows users to finely control the appearance and layout of their visualizations, making it possible to produce publication-quality graphics.

We read the data from CSV files into a Pandas Data Frame. For visualization, Matplotlib was used to create line plots to illustrate trends over time.

3. RESULTS

Please see Appendix A for all figures. As shown in Figure 1, there was an overall decline in Yellow and Green Taxis Total Dispatched Trips starting from 2017. From 2020 to 2021d, Yellow and Green Taxis and Uber and Lyft saw a sharp decline in Ridership, however, Uber and Lyft were able to recover from 2021 to 2022, while Yellow and Green Taxis continued to lag.

Figure 1 was created by using Python code to visualize transportation patterns using Open Data resources for New York City transportation options as described above.

The code employs Pandas and Matplotlib to analyze and visualize trends, showcasing yearly totals for Green, and Yellow Taxis, and monthly trip counts for Lyft and Uber from 2017 to 2022. Yellow taxis can pick up passengers anywhere in NYC, primarily in Manhattan and at airports, while green taxis are restricted to pickups in the outer boroughs and upper Manhattan. The resulting graph provides a comprehensive view of the evolving transportation landscape in NYC during this period.

Figure 2 shows a decline in Bus and Subway ridership in 2020 during the COVID-19 Pandemic. Ridership has continued to lag in 2021 and 2022 relative to the ridership of ride hailing apps.

Figure 2 was created by using Python code to utilize data from the Metropolitan Transportation Authority (MTA) as described above. The graph uses a line plot depicting annual ridership trends for MTA bus and trains from 2017 to 2022. The data is sourced from the MTA website, and the code uses Matplotlib, NumPy, and Matplotlib to generate the graph. A trend line, produced through linear regression, visualizes the overall trend in MTA train ridership over the specified years.

Figure 3 describes CitiBike ridership patterns. Citi Bike ridership peaks upward in the summer months, when the weather is warmer, but peaks downward during the Winter months, when the weather is cold. There has been an overall increase in Citi bike ridership from 2017 to 2023.

Figure 3 is created by using Python code to utilize the Pandas' library to read and process monthly Citi Bike trip data https://citibikenyc.com/system-data obtained from the Citi Bike website. The data is sourced from multiple CSV files, each representing a specific month's trip data. The code then compiles the counts of trips for each month across multiple years, creating a line plot to visualize the monthly trip trends. A trend line is calculated using linear regression to illustrate the overall trend in Citi Bike trips from January 2017 to December 2022. The x-axis is labeled with months and years, while the y-axis shows the number of trips. The graph provides an insight into the changing patterns of Citi Bike usage over the specified time frame.

4. DISCUSSION OF RESULTS

The shift in transportation preferences, from the traditional yellow cabs to the ride-hailing services like Uber, in New York City is connected to several factors. One important factor is that ride-hailing is more convenient and flexible for customers than the conventional taxi business. Many users have shifted to ride-hailing services owing to the convenience of making a ride request with a simple tap on a smartphone application and the availability of rides at any time. Also, most of the time, ride-hailing is done in a more personalized manner, with better design of service, including the ability to choose what type of vehicle, as well as real-time monitoring of the trip. Over time, these ride-hailing companies have established, through affordability of their service prices and promotional incentives, more loyalty from their customers. However, the plunging demand for

ride-hailing amid the COVID-19 pandemic shows the vulnerability of such services to disruptions. The demand for ride-hailing services during the COVID pandemic was sharply reduced by lockdowns, social distancing measures, and fears of viral contagion. With cities gradually coming back from the pandemic and easement in mobility restrictions, the adaptations and evolution of the ride-hailing service matching the need and changing preference of the consumer in mobility continue to take new shape.

We also looked at the use of CitiBike as a way of measuring different modes of urban mobility. It is a flexible and eco-friendly option for transportation, but to make it effective and sustainable, infrastructure development and safety measures for riders need to be prioritized. Adequate bike lanes, designated parking areas, and flawlessly integrated systems with the public transport networks are the keys to support the expansion of Citi Bike and usability (Basch, 2020, lines 35-39). Ridership could continue to increase if efforts to increase safety among riders through education, traffic law enforcement, and access to appropriate safety equipment is continued. The infusion of technology into Citi Bike operations can only improve the safety and user experience, thus making cycling in urban environments much safer and more enjoyable. By emphasizing infrastructure and safety, cities maximize the value of bike sharing for programs like CitiBike. They minimize traffic congestion, and emissions, as well as ensuring that city residents and visitors pursue a healthy lifestyle.

From this analysis, we have learned that the shift in hired car based transportation preferences in New York City reflects a broader trend towards seeking greater convenience and personalization in urban mobility. The rise of ride-hailing services highlights the benefits of flexibility and real-time access but also reveals their susceptibility to disruptions such as those experienced during the COVID-19 pandemic. Also, the Citi Bike program study shows the importance of integrating sustainable transportation options with supportive infrastructure and safety measures. Ensuring the success of such programs requires a focus on infrastructure development, technological enhancements, and rider safety.

5. CONCLUSIONS AND LIMITATIONS

New York City's public transportation system is the largest in the United States. In large part, the extensive subway system and the strong bus network nearly eliminate dependence on personal vehicles, a fact that sets this city apart from other regions in the country. In addition, infrastructure and urban planning for decades have been created to support environments of high density, making the city "public transit friendly." Further embedded in importance and centrality is the role of public transport in daily commuting and traveling.

We are confronted with complications in conducting a literature review for the quest of past studies to base our research. Many of the available studies deal with the concept of shared economy in general and do not focus on the exact industry of interest—namely, ride-hailing services. This limits the applicability and insights for our study. Additionally, the generic nature of previous research often fails to capture the unique nuances and challenges specific to ride-hailing services, highlighting the necessity for more focused research in this rapidly evolving field. Furthermore, the technology and regulatory environment are in a state of constant flux, causing existing research to age quickly and making it challenging to find relevant, up-to-date data. These gaps underscore the critical need for comprehensive and targeted research to gain a deeper understanding of the dynamics and impacts of ride-hailing services, especially in unique urban settings such as New York City. Moreover, understanding consumer behavior, market trends, and the socio-economic effects within this specific context can provide valuable insights for policymakers and stakeholders aiming to optimize the integration and regulation of ride-hailing services in metropolitan areas.

6. ACKNOWLEDGEMENTS

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7. REFERENCES

Basch, C. H., Ethan, D., Fera, J., Kollia, B., & Basch, C. E. (2023). Micromobility vehicles, obstructions, and rider safety behaviors in New York City bike lanes. *Journal of Community Health, 48*(3), 522-527.

Citi Bike System Data | Citi Bike NYC. (n.d.). Citibikenyc.com. https://citibikenyc.com/system-data

NYC Open Data. (n.d.). FHV base aggregate report. *NYC Open Data*. https://data.cityofnewyork.us/Transportation/FHV-Base-Aggregate-Report/2v9c-2k7f

Faghih-Imani, A., Anowar, S., Miller, E. J., & Eluru, N. (2017). Hail a cab or ride a bike? A travel time comparison of taxi and bicycle-sharing systems in New York City. Transportation Research Part A: Policy and Practice, 101, 11-21.

Joshi, M., Cowan, N., Limone, O., McGuinness, K., & Rao, R. (2019). E-hail regulation in global cities. New York, US: NYU Rudin Center for Transportation.

NPR. (2018, August 9). What Led To New York City's Legislation To Cap The Number Of Ride-Hailing Vehicles. NPR; NPR. https://www.npr.org/2018/08/09/637230104/what-led-to-new-york-citys-legislation-to-cap-the-number-of-ride-hailing-vehicle

Rosenthal, B. M. (2020, November 12). Pandemic Pushes N.Y.C. Cabbies to the Brink: "I Can't Hold On." The New York Times. https://www.nytimes.com/2020/11/12/nyregion/nyc-taxi-drivers-coronavirus.html

Tirachini, Alejandro. "Ride-hailing, travel behaviour and sustainable mobility: an international review." Transportation 47.4 (2020): 2011-2047.

"TLC Trip Record Data - TLC." Www.nyc.gov, www.nyc.gov/site/tlc/about/tlc-trip-record-data.page

Zhang, Y., Li, B., & Qian, S. (2023). Ridesharing and urban anomalies: Evidence from the Ne market. Information Systems Research, 34(4),

Salleh, S. S., Jafri, N. N., Roslan, S. N. A., Sanadi, S. Analytical Hierarchy Process in Evaluating Safety Concerns.

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APPENDIX A

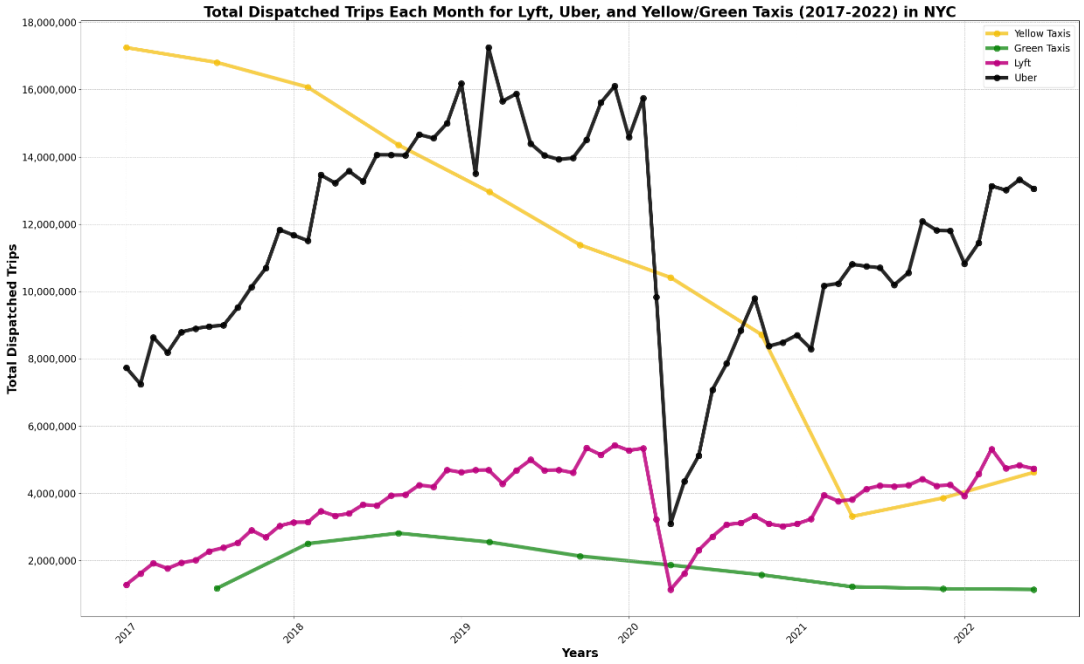

Figure 1 - Total Dispatched Trips Each Month for Lyft, Uber, and Yellow/Green Taxis in NYC (2017-2022)

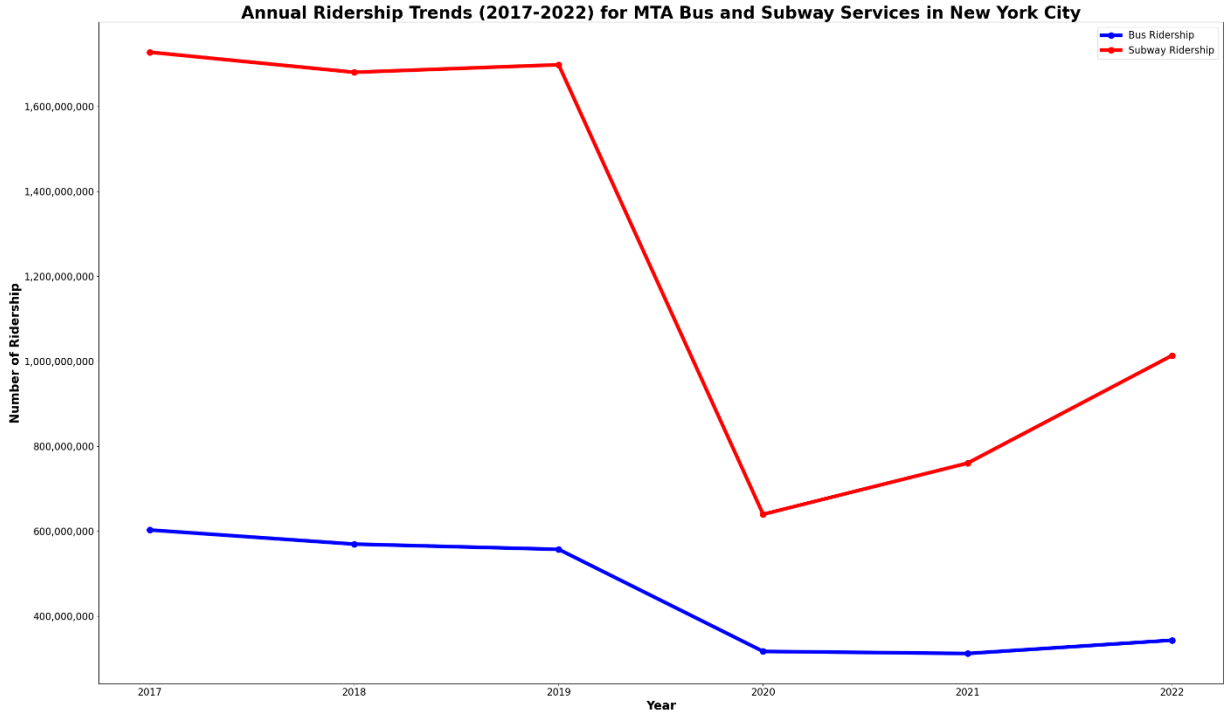

Figure 2 - Annual Ridership Trends for MTA Bus and Subway Services (2017-2022)

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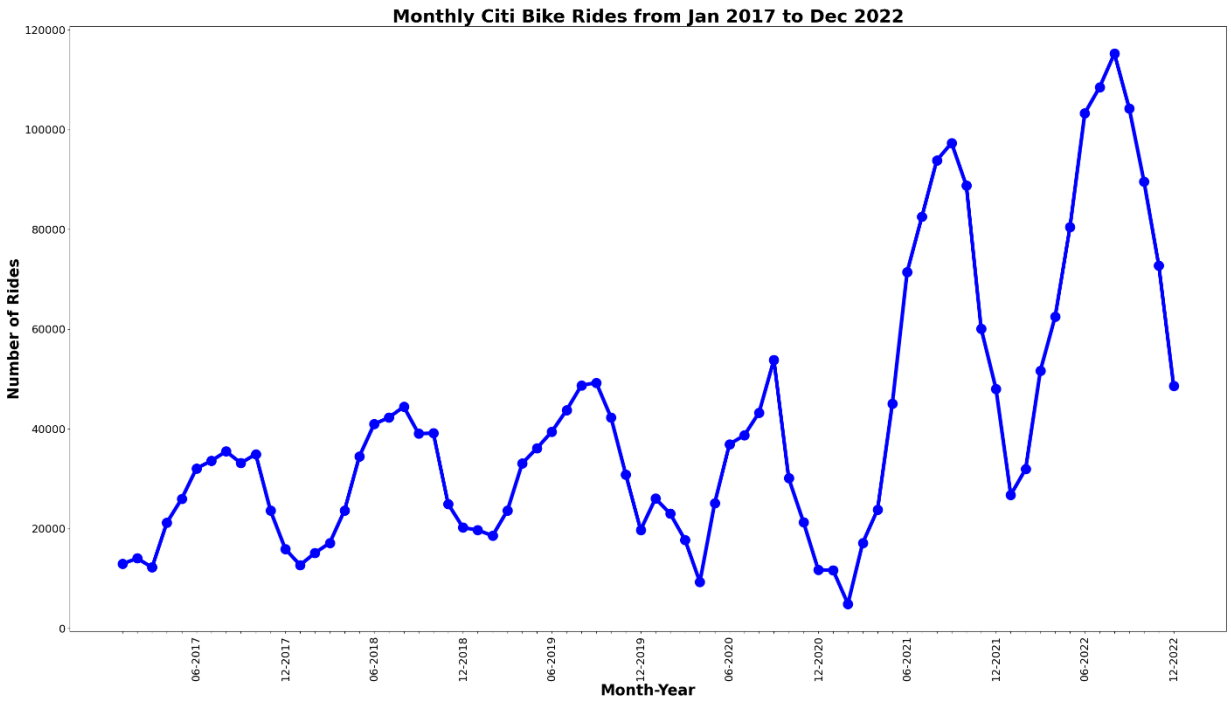

Figure 3 - Monthly Citi Bike Rides from January 2017 to December 2022